THE ECONOMIC SIDE OF WORKS MANAGEMENT

A THESIS PRESENTED TO THE FACULTY
SCHOOL OF THE UNIVERSITY OF PENNSYLVA
TIAL FULFILMENT OF THE REQUIREMENTS
THE DEGREE OF DOCTOR OF PHILOSOPHY

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JOHN CHRISTIE DUNCAN

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PREFACE

THIS thesis appeared in 1907 in the *Business World* under the title of *The Economic Side of Works Management*. The understanding was that reprints would be made, but, unfortunately, before that could be brought about the magazine changed hands, the manuscript was lost, and the plates destroyed.

The writer would have reprinted the articles as they appeared in the *Business World* had it not been for the fact that the paper was materially changed for editorial purposes without his knowledge or consent, and some of the parts were omitted which should have appeared. To have reprinted the paper as it appeared in the *Business World* would not have done justice to the thesis nor have been a creditable piece of work for a Doctorial dissertation.

In the meantime the writer had started a book on the general topic of the *Principles of Industrial Management*, and had used his thesis notes as a basis for the third part of the book. The publishers of the book did not feel free to let the rewritten thesis appear before the book, and as it was impossible to reprint the original thesis, the authorities of the University of Pennsylvania very generously consented to accept the third part of the book in order to fulfill the technical university requirements. This reprint contains all the original matter in the first thesis, but it is presented in a little better form.

CHAPTER XIII

THE THREE TYPES OF ORGANIZATION

In Parts I and II the questions which the business executive must consider have been discussed. The creation of an ideal equipment solves about one half of the problem of industrial management. The plant must yet be put under a satisfactory organization before it can be well managed. The works manager must so combine the equipment which has been given him with labor and material that the product of the plant will be the cheapest and best that can be manufactured. The sales department must put the goods on the market efficiently.

The works manager's field in the concern is limited to the production department of business. His work begins with the receipt of the order and ends with its shipment. He has nothing to do with the soliciting of orders, he is not concerned with the finances of the firm nor with its legal difficulties. His work begins and ends with production. To perform his duties ideally:

1. He must get the work performed rapidly.
2. He must get the work performed accurately.
3. He must get the maximum result from the machinery.
4. He must get the maximum product from the raw material.
5. He must see that improvements in methods are introduced.

In order to get this work performed, there have been evolved three kinds of industrial organization—the military, functional, and departmental types.

The Military System of Organization.—This is the oldest and was almost the only one until very recent years. According to the military scheme, all power and authority for directing the work emanate from one man, who is held responsible for everything that is done in any part of the division under his control. With his plan the leader does not give general directions and then look for results. He keeps control of all details that arise within his sphere of command. The armies of former ages were run according to this plan. The general-in-chief gave directions concerning the health of the men, the way they should march; he saw to the provisioning of the troops, and in fact Cæsar, Napoleon, Frederick, and many other great military leaders, directed the affairs of the state as well. Curiously enough the modern army is no longer run according to the old style military system. The health of the troops is under the care of a distinct body of men, the provisioning and supplying of the troops is attended to by another group of officials. The commander-in-chief now decides upon the general plan of the campaign. He plans where and how battles shall be fought, but modern warfare no longer makes it possible for him to lead his men as did the youthful Alexander, the great Napoleon, or as did Scott, Lee, or Grant in American history. The army now has a staff organization which corresponds very closely to the departmental system used in the progressive firms of to-day.

With the military system of industrial organization every officer in each division or subdivision is held responsible for all that happens within his province. No matter what mistakes are made, he is the one who must stand the consequences. If a foreman has charge of a shop and that shop runs behind in orders, is extravagant in the consumption of supplies or power, or is deficient in the quality of work turned out, the foreman in charge is responsible. He is given a division presumably sufficiently small to make it

possible for a reasonably good man to look after details, and everything is considered distinctly within the scope of his duties. He is expected to keep his men always supplied with work. He must see that the machines are in working order. He must be able to select good men and keep them. If any question arises concerning how things should be done, he should be able to give explicit directions. He must detect work that is not properly done, know on whom to saddle the blame, and must also remedy the faults. In a word, he must be a thorough, all-round man to fill his place properly.

A trained man of ordinary ability can efficiently direct from fifty to one hundred and fifty people in simple, ordinary tasks which require little mechanical ability. It is only the exceptional man of considerable experience and familiarity with the work who can profitably direct more than one hundred and fifty or two hundred workmen. In continuous industries, of both the synthetical and analytical types, a large number of processes are simply and easily directed. The work is almost entirely routine. The machinery is nearly if not quite automatic. There are no great calls upon the intelligence of the foreman, because there is very little to be done outside of seeing that the workers are at their posts and are turning out an adequate amount of material. In such industries, the military organization is ideal, because the task should be quite within the limits of the foreman's ability, and the responsibility can be constantly fixed upon him. If he fails to prove equal to his position, there is no great difficulty in obtaining another man. Generally speaking, the executives of these types of industries do not find their labor management problems difficult of solution in the production departments. Their energies can be directed toward the distributive department, and to finding a corps of workers who will develop the mechanical efficiency of the machinery, look to the economies of the processes and power-saving possibilities and to other similar questions.

In industries which depend to a greater extent upon the ingenuity and efforts of the laborer who cannot be so greatly aided by machinery, the military organization shows its weakness.

The machine shops in the assembling industries were the first to feel the limitations of the military system. For many years, no one noticed its deficiencies, because the shops were small and one man could attend to all the details and give a fair degree of satisfaction. When, however, the departments grew to more than two hundred workmen, the scheme began to break down. No one could look after all the details of so large a shop. It was useless to discharge the overseers, because no one could be found equal to the task. It is a dictum in management that if punishment by discharge does not eliminate failures and mistakes in an organization the scheme in itself is vitally wrong.

Works managers gradually came to appreciate that the defects were due to the system, so they sought to eliminate the weaknesses of too highly concentrated authority by dividing the leadership among several men, each being equally responsible to the superintendent. This solved the problem of giving the foreman a reasonable number of people to look after, but it increased the unproductive labor expenses and tended to make a conflict in authority and interests. For example, the foreman of the machines in order to make a good showing would be apt at times to have his men rush the work through in a hasty manner, expecting the erecting gang or bench hands to make good his deficiencies. The bench foreman would also slight his work. If heavy castings were to be moved by the cranes, two foremen, equal in authority, would put the riggers and crane men in an exceedingly unpleasant situation because both would insist upon immediate attention. There was but one outcome. The riggers served whomsoever they pleased. The writer is familiar with a shop where the riggers were bribed by an ambitious

gang boss to attend to his requests. He needed the services of the crane for a considerable length of time. However, there were intervening periods of a half hour or so in which the crane could be used to fill machines and move other castings. Instead of using this time and making the favored man wait an occasional quarter or half hour, the riggers stood by the job, holding up the machines and erectors the better part of the day. Of course this is an exceptional and most glaring example of the weakness of this scheme, but it is nevertheless a weakness which grows out of too extended a spreading of the military system.

Briefly summarized, the advantages of the military system of management are:

1. It unifies the work, putting it all in the hands of one individual.

2. It fixes the responsibility for the performance of tasks in a definite manner upon certain individuals.

Its disadvantages are:

1. When a plant becomes too large the foremen are held responsible for too many things, and cannot justly be held accountable for blunders or for smallness of productivity in machines and men.

2. The foremen have so much to do that they cannot see to the introduction of improvements as rapidly as is desirable.

The military system of works organization in a large concern leads to chaos in management, because it fails to prevent bad work and to stop the nursing of jobs. It has no means of rewarding the efficient man or of punishing the poor worker or loafer. Managers of plants who worked with the military system in their younger days were puzzled as to why the later generation developed so few good foremen and why it brought forth so many poor workmen. They did not recognize the fact that it was due not to a degeneration in the younger members of the community but to an inherent fault in the system. Thoughtful students felt the need of some-

thing, but hardly knew what. Some plants tried varying schemes of running their work. Several concerns hit upon the plan of piece wage payment and careful inspection of material by independent inspectors who were held responsible. This scheme has worked with a reasonable degree of success, but there are so many ways of fooling the inspector and of getting bad work passed, and there are so many possible evasions of the piece wage scheme that it was soon realized that another change was necessary before this method would prove efficient. The piece wage payment and inspection scheme did lead to something better.

Piece workers, on account of the fact that they are working for themselves, are insistent upon allowances being made for all kinds of contingencies. The manufacturer finds it more profitable to lighten their duties, and to limit as little as possible the movement of the workers. He soon begins to study how the work can be divided and men assigned to certain parts. From this development arose the functional system of organization.

The Functional System.—The greatest exponent in America of the functional system of organization is Mr. Frederic W. Taylor, a past president of the American Society of Mechanical Engineers. Mr. Taylor has held a great number of responsible positions in various sections of the country, and has made an enviable reputation in the engineering world. His paper entitled "Shop Management," delivered before the Society of Mechanical Engineers, is a memorable contribution. In that paper he discussed the management of a shop under the functional system of organization.

"Functional organization consists in so dividing the work of management that each man from the assistant superintendent down shall have as few functions as possible to perform."[1]

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[1] Cf. *Transactions American Society of Mechanical Engineers*, Vol. XXIV, Paper No. 1003, p. 1391.

The scheme is based upon the theory of the division of labor as applied to management. A workman in a machine shop according to this plan is not under one but several foremen. Mr. Taylor advocates four shop bosses: gang boss, speed boss, inspector, and repair boss. The gang boss has charge of preparing the work up to the time that the piece is set in the machine. He must show his men how to set the work on the machine in the quickest possible time and in the best possible way. The speed boss has the function of providing the proper tools for the workman on the machine. He must see that the cuts are started at the right place and that the machine is speeded up to its proper limit. The inspector is responsible for the quality of the work, and both workmen and speed bosses must finish the work to suit him. The repair boss sees that each machine is kept in working condition, is clean, free from rust and scratches, and is properly oiled.

In addition to these four shop overseers the workmen come into contact with the representatives of the planning department, whose function is to relieve the shop foremen of all thought of how the work should be arranged and distributed to the machines. Four representatives of the planning-room also come in contact with the workmen, the order of work or route clerk, instruction card man, time and cost clerk, and the shop disciplinarian. The route clerk writes a daily list, instructing the workmen and all shop bosses as to the exact order in which the work is to be done by each class of machines or men. The instruction card man states in writing the general and detailed drawing to refer to, the piece number and cost order number to charge the work to, the special jigs to use, the depth of cut to be made, the number of cuts to make, and the time in which the job should be finished. He also sets the piece rate. The time and cost clerk sends to the men through the instruction card all the information they need for recording their time and cost of work, and he secures the proper returns from the men.

"In case of insubordination or impudence, repeated failure to do their duty, lateness or unexcused absence, the shop disciplinarian takes the workman or bosses in hand and applies the proper remedy, and sees that a complete record of each man's virtues and defects is kept. This man should also have much to do with readjusting the wages of the workmen. At the very least, he should invariably be consulted before any change is made. One of his important functions should be that of peacemaker." [1]

To quote Mr. Taylor again:

"The greatest good resulting from this change is that it becomes possible in a comparatively short time to train bosses who can really and fully perform the functions demanded of them, while under the old system it took years to train men who were after all able to thoroughly perform only a portion of their duties. . . . Another great advantage resulting from divided foremanship is that it becomes entirely practicable to apply the four leading principles of management to the bosses as well as to the workmen." [2]

The four leading principles of management to which Mr. Taylor refers in this last statement are:

1. A large daily task should be given to the men.
2. The men should be given standard conditions, making it possible to perform the task.
3. They should be given a high pay for success.
4. They should lose in case they fail to reach the requirements of the daily task.[3]

Viewing the subject from a broader point of view, there are other advantages to be gained from the functional organization.

1. The work is divided so that one man need attend to only one thing. It enables complete specialization of labor.
2. It definitely fixes the responsibility for the performance of each function upon one man.

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[1] *Transactions American Society of Mechanical Engineers*, Vol. XXIV, pp. 1393, 1394.

[2] Ibid., p. 1394. [3] Ibid., p. 1368.

3. It allows the workman opportunity to think out improvements by enabling him to make an intensive study of his work.

Notwithstanding all of these advantages the functional system of organization has not proven popular or successful in a number of plants where it has been tried. It causes men to lose initiative. It has a tendency to shift and divide the responsibility in spite of the contrary intention. This has been found to be true in several places where the plan has been tried. The difficulties that have been encountered in carrying the scheme through are:

1. It requires a great amount of clerical work to fill out instruction cards and write out all orders and minute instructions necessary for the complete enforcement of the scheme.

2. It is exceedingly hard at times to define clearly to whom certain functions belong and on whom the responsibility rests when things go wrong. For instance, no less than eight bosses outside of the shop disciplinarian come into direct contact with the workmen. Four of these men make out instructions, and four others say how they should be carried out. It not infrequently happens that the man who makes out the instructions is somewhat vague in his directions, in the hope that the speed boss or gang boss will make up deficiencies. If a mistake occurs under these conditions, it becomes a difficult matter to determine who is to blame, because the instructions man will plead that they were not interpreted correctly and the other bosses will assert that such interpretations could be made. Sometimes the instruction card man will give instructions and the gang bosses may see a better method. If they do, the chances are that they will want to put their scheme into operation. Hence there will be a conflict of authority. If a boss adheres to the system and doesn't follow the best method possible under the circumstances, the firm is paying for a system of man-

agement which is failing in its purpose of getting the goods out in the cheapest possible manner.

3. It is cumbersome and expensive to operate. In every shop the jobs must be assigned to men at all kinds of odd times during the day. If a workman desires to start on his job he must come into contact with at least three of those bosses before he can do anything. There are usually several men desiring jobs at one time. Under a system where the workman is supposed to know how to set up a job and interpret instructions, he merely needs to find out what he is supposed to do, and do it, calling on the boss only when there are complications. With this functional scheme he is not supposed to act on his own initiative. As a matter of fact, so many bosses really hinder the work. They irritate the men and are expensive to keep up, because in a large shop they must have a number of sets of bosses to carry out the scheme as laid down.

The Departmental System.—In advocating the functional system of works organization, Mr. Taylor made a valuable contribution in that he brought out the idea of dividing the work in such a way that it could be looked after by functions rather than by complete units. No plan of organization can be successful unless it is workable. The military type fails to be workable in large organizations, because it is impossible to get men who are capable of filling the leading positions. With the functional plan it is possible to train a sufficient number of men to carry out the functional duties, but it is only under the most exceptional conditions that these various functions can be clearly defined and the scheme worked without conflict and irritation. If there is a remarkable man at the head who can smooth all points and be everywhere present whenever a difficulty arises with conflicting ideas and authorities, the system has a chance of working; but in this every-day world a highly sensitive organization of that character, no matter how perfect on paper,

is bound to be disrupted by the bumps and collisions of daily strife. A finely adjusted, compensated astronomical chronometer will keep perfect time, provided it is wound up at certain stated intervals, and is kept from jars and vibrations and extremes of temperature, but for ordinary day use to carry around in the pocket, a dollar watch may prove more satisfactory. Works managers need the dollar-watch combination, and they have found it in combining the good features of both the military and functional systems of organization. Hundreds of plants at the present time use the departmental system without being fully aware of what they are doing. The departmental system does the following things:

It divides the plant up into a number of clearly defined departments, and puts each under the control of a gang boss, who is given general directions to work to and is held responsible for results and not for servile attention to detailed instructions. Thus in a machine shop there is a man to look after the large machine tools, such as lathes, planers, and milling machines. Another foreman will be appointed to look after the erection of the large parts of the engine, another will be given a valve-setting gang, and still another may be given charge of the tool-room, and another will look after the stores. The riggers or crane men will be under a sub-foreman, who will have to keep all the machines supplied with work. In addition to these, the repair department will be in the hands of one man, a tool-making and grinding department in the hands of another, and the stores department in the hands of another. All of these men will be under a head foreman or superintendent. Each man is held responsible for the output of his machines. When a set of drawings of an order comes into the shop, the head foreman will examine the drawings and call in the various gang bosses. He will tell them the things they are to look after. Each man clearly understands, from either written or oral instructions,

his particular province. It is then his duty to keep his machines going and his men employed on their particular tasks. The work, when performed and inspected, is passed on to the other departmental boss. If the succeeding gang boss finds any defects in the work, he must at once report the mistakes, or he will be held responsible for all defects uncovered by his immediate successor.

The departmental system divides the work up into small departments, each under the absolute control of a man, and the departments are so related to each other that no individual workman will have to obey two bosses. The riggers, for instance, in the military system served any man upon request. In the functional system, the riggers obey a rigging boss who is at the beck and call of a half dozen functional foremen. In the departmental system, the rigging boss learns from the head foreman the conditions of the large castings, and about when they are to be moved, and adjusts his gangs in such a way that there will be a minimum of waiting throughout the entire shop. If the head foreman finds any men idle due to the fact that they cannot work because castings are not moved, he can at once ascertain whether the boss rigger has arranged the movements correctly, or whether there is insufficient crane service. Whatever the reason, there is one man from whom an explanation can be demanded and readjustments promptly made. If the machines are not turning out sufficient work or are giving poor service, the departmental boss cannot blame the speed boss or an instruction-card boss. He has the machines to look after. If his men are not efficient, he is to blame, because he should report and discharge the delinquents. If the machines are in bad condition, he is at fault, because it is his duty to report defects and breaks at once, and insist that they be repaired. A machine boss should never let a machine get into general bad repair. The erecting boss is to blame if the erecting is progressing slowly or is poorly done. The great

advantage of this departmental system is that the responsibility can be fixed; it is possible to train men to fill the jobs, and it is impossible to have any shifting of responsibility, because the men must show results in output, and not prove that they have given or followed instructions.

CHAPTER XIV

THE LABOR FORCE

Before the employer can decide how he is going to run his labor force he must determine what kind of labor he is going to use, because his treatment of employees will be influenced to a very great extent by the labor personnel. The labor force may be men, women, or children. Adult male labor is for the greater majority of the important industries the most profitable kind of labor. There are, however, a great number of industries wherein women and children may be employed with profit, because they work for less wages and have their natural aptitudes for the work. The industries that can employ women and children are the textiles, shoe factories, and other concerns which produce either light materials or goods which require deftness in handling. We may compare male and female labor in the following way:

1. Comparison of Male and Female Labor.—Male labor is stronger and has greater physical endurance. Men alone are able to stand long-continued heavy work, such as is required in a shipyard, steel plant, or locomotive shop.

2. Men are more apt to be permanent employees. The home is woman's ultimate sphere. A woman's maximum working period in industrial occupation is usually limited to the time she leaves the grammar or high schools until she reaches the age of thirty. In that time, she may serve an apprenticeship to a trade, and become a capable, conscientious employee. She is, however, apt at any time to marry and leave work. Marriage increases a man's value to the firm, because he now has new responsibilities to shoulder, and is more desirous of giving satisfaction to his employer.

3. In general, men have more initiative than women.

Man's initiative is not due to superior brains, but is the result of greater opportunity. In the city, night schools, Young Men's Christian Associations, correspondence schools, and public schools offer inducements in the way of courses of study which men can pursue during their evening hours. These courses of study are designed primarily for men's needs in industry. A great number of the evening schools inform the employers of the progress their hands are making in the courses, and the employer is consequently apt to give such persons greater opportunities. Women in the same lines of occupation do not have the same encouragement, they are less able physically to work all day in the mill, and then to carry on technical studies after working hours. There is a lack of incentive to attend these courses, because they do not in most cases regard their work as a life's career. Moreover, thousands of women and girls, after they leave their factory at the close of the day, have household duties to perform for parents or for the male members of the household, who are also engaged, perhaps in the same mill or factory. Even if they do not engage in those duties, a girl invariably has a great deal more to do than a man; she usually makes much of her clothing, often trims her hats, repairs her garments, and looks after a thousand and one things which a man turns over to some one else and pays for having done. All these things combine to make man possess more initiative. He has more opportunity to learn how to do harder things, has a better physique, a greater incentive to make an effort to learn, and less of other things to do.

4. Woman's clothing is a hindrance to her, and she can be employed only in places where the machinery is of such a nature that her clothing will make employment safe. In places where she could otherwise be more serviceable than a man, firms take the trouble to design the work-room and machinery in such a manner that she can be employed with safety.

5. Women's hours of labor are more closely restricted by law. Our labor laws justly seek to throw more protection around women and children than around men. The manager of a plant, however, cannot afford to overlook the fact that these are disadvantages when he considers women as prospective employees, although it is only a question of time when the law will place greater restrictions upon male labor. Legislation and common justice require conveniences for women in wash-rooms, and a supply of chairs for resting during the working period. Their hours of daily and weekly labor are shortened, and they may not be permitted to work overtime except in rare and carefully guarded instances.

6. Men are more disposed to form permanent labor unions; and, in this respect men may be more difficult to deal with than women as regards wage increases. Women do not lack organizing capacity, but they are apt to regard their industrial grievances as a temporary inconvenience not worth the effort to remedy.

In the long run, powerful labor unions are better for society than unorganized labor. If the laborers of all industries are united in their demands, no hardship is imposed upon any manager, because all are on the same basis. If, however, one concern is compelled to yield to certain demands which involve an outlay of money, and its rivals are not also put to the same trouble and expense, it is working under disadvantageous conditions.

Although women do not readily organize into permanent labor bodies, in some respects they are harder to manage than men. Many a successful foreman of men would wreck his reputation if he applied his methods to women. Tact is required to get good results from the girl in the factory, mill, or office.

7. Women have an aptitude for certain classes of work. In hosiery mills, silk spinning establishments, and a great

many operations in textile works which require painstaking care and deftness, women are better employees. In pottery works her lighter touch and more appreciative sense of beauty are valuable assets.

8. Women work for less money than men. Manufacturers and managers of establishments which employ women, agree that in the lines in which they employ the women, they do so because the same grade of men would demand a larger wage.

Under these conditions, the manager of the concern must study carefully his industry and the parts of his industry to see where he can introduce female labor. In lines of work where it is a question of deftness of fingers and lightness of touch or skill in running small machines, women can be employed to advantage. Anyone who has visited the National Cash Register works will be impressed with the proportion of women and girls employed on drilling machines and machinery, which finishes and prepares the small iron and steel parts of the register for the assembler's hands. Some electrical manufacturing companies employ women exclusively in a number of their departments. In commercial lines, large firms employ several hundred women in their bookkeeping departments. In one concern the entire bookkeeping staff is composed of women who are under the direction of a man head accountant. Whether women or men shall be employed depends upon whether the work can be adjusted so as to suit the peculiar aptitudes of women.

Child Labor.—In some classes of industries children may be employed. The child can be used in a great number of operations in textile plants, glass factories, coal breakers, and other establishments. Society pays a high price for child labor in decreased vitality and efficiency of its adults, and is now restricting the liberty of the manufacturer to use children. The child as a laborer has only one advantage to the manufacturer, that of being cheap. Against this advan-

tage the manager may well weigh the disadvantages of child labor.

1. Their hours of labor are limited by law in most states, and in those industries where children are employed they are apt to limit the hours of the adults, or to compel the management to make disproportionate equipment for the child, as compared with the adult, departments. The adults are dependent upon the children for their material, and when the child department shuts down, the adult department may have to discontinue.

2. Children require more careful overseeing. They are more apt to destroy or spoil material than their elders, are harder to keep at work, and require a greater degree of attention and direction. Unless constantly watched, their little minds wander from their tasks. They are full of animal spirits, and when not under observation will play pranks, which cause production to cease, and even frequently destroy goods.

3. Children are more careless about machinery than are adults, and more likely to be injured. They are not safe workers in a plant.

The casualty insurance companies do not as a rule care to insure children. Some companies refuse to accept risks upon any child under fourteen years of age.[1]

Nearly every firm employs boys of seventeen and under for messengers, elevator attendants, and similar workers. The only reason for employing boys for such positions is their willingness to accept low wages. In spite of his small remuneration, the boy is not cheap when one considers his unreliability. Some firms have had so much trouble with

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[1] This rule, if not already adopted by almost all casualty companies, soon will be on account of the general tendency of states to raise the minimum working age of children to fourteen years or over.

boys in filing rooms, as messengers, and as office assistants that they are now employing for such places men who are well past middle life and are getting better results. Such men ask for more wages, but they are well worth the extra pay, for they are much more careful, reliable, and faithful in fulfilling their duties than the youngsters, and far less apt to leave.

From the broad, social point of view it is a question whether boys ought to be engaged in such occupations as messengers, elevator attendants, and office assistants. From fourteen to eighteen a boy should be preparing for his future career; if he cannot attend school or college he should be serving an apprenticeship to some trade, or be working at something which will enable him to fill a place of usefulness in some office, store, bank, or similar place in later years. Being an office, elevator, or messenger boy, is not giving him this preparation; and he should not be so occupied unless it is merely a temporary expedient to obtain a position which will give him a chance to develop his faculties for greater things. The engaging of men past middle life for such places, on the other hand, confers a social benefit, and is more satisfactory to the employer, all things being considered. Besides making his selections of laborers along the lines of sex and age considerations, the manufacturer must consider the educational qualifications of his employees.

Classes of Laborers.—All industries require one or more of three classes of laborers as regards mental caliber, education, and training.

I. *Unskilled Workers.*—In the continuous industry of the synthetic type these men are used to a very great degree. Large numbers of them are required in steel plants as laborers around blast furnaces, coke ovens, the steel furnaces, and other departments. In previous years they were more widely used than at the present time. Some years ago they were employed in great numbers around paper mills, textile

establishments of all kinds, and other plants of a similar nature, but this type of laborer is being largely eliminated from the steel plant, and he is gradually passing away from all plants as a type of worker. Conveying machinery is now so extensively used and is so efficient that the unskilled laborer is no longer profitable. In the steel plants, he is still needed to some extent to look after coke, slag, and other materials, to shovel dirt and to attend to cinders, but his days are numbered, not only for steel making and continuous industries, but for every other type of industry wherein the only qualifications are strength and willingness.

In the analytical continuous industries, great numbers of these laborers are required to perform the unpleasant work of unloading raw sugar, of cleaning out apparatus around the sugar, oil, gas, and meat-packing establishments. They are also necessary as attendants in firing boilers and, before the introduction of conveying machinery, were required to carry the material from department to department. Conveying machinery has eliminated the laborer as a draft animal, but machinery has not made it possible to remove him from doing a number of other unpleasant duties. In time it will, and it is distinctly to the management's interest, as well as society's, to take him away as soon as possible.

In the assembling industries, the unskilled worker was formerly employed to transport the material from the foundry to the machine shop and between departments in the shop. He was a necessary adjunct around the shop to pull on the ratchet for drilling holes, to sledge, to chip the rough castings and set the material up on the machines for the machinist to finally adjust, but now the new factory has the overhead crane which reaches every part of the shop. A hydraulic lift or chain block can be placed at every machine, so the laborer is no longer helpful there. Likewise, the air drill, air hammer, riveting machine, and air-chipping machine take away his job in chipping, riveting, and sledging.

In a word, this laborer is being eliminated to such a degree that he will soon become extinct.

II. The *intermediate grade of laborer* whose qualifications in addition to regularity and good health must be:

1. Ability to learn to handle machinery of a more or less semi-automatic type without injury to himself.

2. A willingness to attend closely to such machinery, seeing that it is constantly running properly, and is always supplied with material to keep it producing.

3. Ability to keep the machinery in his charge in good running order.

There are three types of machines:

(1.) The machine which needs an attendant merely to keep it filled. Examples of this type of machine are:

(a) The endless screw-conveying device, which mixes the various grades of raw sugar and molasses so that they become semi-liquid, capable of being pumped from a tank to the top of the building, from whence they are started on their refining process.

(b) Shears, punches, and other cutting devices used around iron works, shipyards, and such establishments to cut up scrap iron, plates, punch rivet holes, etc.

(c) The filter presses in oil works, potteries, and plants which have straining or filtering processes.

(d) A great many automatic screw-making machines and nail cutters. These machines merely need a rod shoved in at one end from time to time, or a roll of steel wire occasionally started going through the apparatus. Everything else is done completely by machinery.

(2.) The machine that does most of the work but requires an attendant to be present to make occasional adjustments and to see that the machine is running in such a way that the material going through is not being spoiled. Examples:

(a) The modern turret lathe, wherein the attendant need only put the bolt or nut blanks in and see that as each step

is completed on the machine the succeeding tool is applied to do the next step at the proper time.

(b) The modern drill press. In some cases the drill press has a great number of spindles, so that the one machine turns out a number of pieces of work at the same time. Here the attendant must be constantly on the alert to see that the various spindles are supplied with material in order to keep the entire machine productive.

(c) The modern loom—an excellent illustration of this type of machine. The more recent loom will stop whenever a thread breaks in either direction in the cloth. The attendant must be capable of tying the broken threads and starting the loom at any time. He must be deft in handling the material and must not mix threads or get them tangled in the weaving process.

(d) The modern spinning frames or spinning mules. These do not require very great skill on the part of the attendant, but do need adeptness in handling the fine threads.

(e) The slotting and modern key-way cutting machines of the machine shop. The attendant must adjust the feed or rate of cutting to suit the requirements of the material or the machines, and must be able to select the proper tools for the various cuts. The tools are readily learned and do not vary with the same material and cut, so that after once learned such machines can be run by an ordinary person.

(3.) The third type of machines requires great skill to run because such machines are designed either to handle a large variety of work which must be performed with exacting accuracy or they require unusual steadiness of nerve and skill to operate. Examples of these machines are:

(a) The large lathes and milling machines in general machine shops. These machines get a great variety of work every day; sometimes they are used to bore out cylinders, again to turn shafting, and in fact one never can tell just what they may be called upon to do.

(b) Large planers and shapers are another variety of the same class of machines. They may be used to cut grooves, smooth off the top of plane surfaces, finish the sides of castings, and the variety of castings they may be required to handle is indefinite.

(c) Steam hammers in forges, such as make ship work and other heavy forgings.

(d) The roll sets which make steel rails, structural iron, ship plates, and other work of a similar type.

This third class of machines requires the services of the third class of workers discussed below.

III. *A high grade of skilled labor.*—The worker need not be of powerful physique, but he must be in good health, and possess the following qualifications:

1. Ability to interpret accurately complicated instructions either from blue prints, drawings, or from written or oral communication.

2. Ability to concentrate attention on details, to use skill and patience in accurately carrying out, in the concrete reality, the pictured idea of the inventor or engineer.

This class of laborer is the most highly skilled non-professional group of people in existence, and must be well paid. Indeed, they frequently obtain wages which compare favorably with the salaries of teachers and the incomes of lawyers, doctors, and other professional men. They are needed in foundries to make complicated castings, in the pattern shop to produce the patterns for the foundry, in the machine shops to run the large lathes and machines to which jobs of varied dimensions are assigned. Such a man is entrusted with valuable material, and if he makes a mistake its results are far-reaching. A pattern-maker once misread a drawing, making the inlet into the condenser on the wrong side of the condensing apparatus. The pattern went through the foundry. The casting came into the machine shop and was machined in many parts before the mistake was discovered, and it cost

the firm some $800 to rectify the error. In another case, a man in charge of one of the large lathes misinterpreted a drawing and turned a certain piece of material one thirty-second of an inch smaller than it should have been. The casting was some forty inches in diameter and seventy-odd inches in length. The mistake was discovered when it was attempted to fit it into the other parts, and it was utterly worthless—a loss of several hundred dollars to the firm. It is absolutely necessary for men holding such places to be thoroughly equipped. To train a man for this rank, he must first of all be intelligent, naturally resourceful, and possess the innate ability to visualize a described idea. To obtain the development of these latent qualities the workman must have:

1. A preliminary education of such a degree that he can readily acquire an accuracy in interpreting instructions. In a word, he must have a receptive, active mind.

2. He must serve an apprenticeship. This preparation must be in shops, night schools, and other places where he can learn more than the mere routine of his tasks. He must attain the attitude of mind that we look for in the professional man, the ability to depend on himself for carrying out work, and an unwillingness to jump at conclusions.

The great problem of a manager in any place is to introduce machinery and so to arrange the work that the unskilled worker will be unnecessary, and the call for the highly skilled man will be small. Unskilled exhausting toil is so monotonous that the employee can take little or no interest in his duties, and the work itself is so unprofitable that a concern cannot afford to give a wage that will encourage men to be alert and faithful. The man reasons rightly that if he gets discharged he can get as good a job in another place; and if he doesn't find an opening, society will give him a living at least, which is little, if any, less than he is now getting out of all his exertion.

An organization which must have a large number of the third class of workman, the highly skilled man, is likewise undesirable, not because his services are not valuable, but because so much depends on him. His grade is so high that it is difficult to obtain him. He is well worth his wages in any organization if he is efficient and does not make mistakes; but if he does err, even occasionally, considerable loss may be entailed. Therefore it is highly desirable to get machinery to do as much of his work as possible.

The second class of worker is the most desirable. The advantages of this class are:

1. A short apprenticeship makes the man valuable to the employer.

2. The employee with his limited capacity feels his dependence on the employer, and is likely to be a faithful and attentive workman because he receives a larger income than the ordinary laborer, and could in most cases obtain employment only as a less valuable man in another place.

3. The employee becomes very dexterous in doing one thing, and is thus able to turn out a large product.

It is possible to run but few plants without using more of the third class than are readily available. They are necessary as bosses and leaders of the first and second groups, and unfortunately they cannot be developed rapidly from either one of them. Shop managers find themselves seriously handicapped, from time to time, in getting men who can take charge of departments, who can become gang bosses and foremen in the various divisions of the organizations. So important has the specialization of labor become that the old style apprentice in the shop has almost completely vanished. A few weeks of practice enables a man to run a loom, but to get a good loom foreman a man should come through an apprenticeship which has taught him every part of the loom and its running mechanism. It takes a very short time to learn to run a drill press or milling machine, but it is an exceed-

ingly hard proposition to get a man who can tell what classes of work should go on the machines, how they should be attached, how the tools should be adjusted, and a hundred and one other such matters. It requires little intelligence to scrape in a valve seat, but it requires skill to set the valves of the variety of engines that come into some of the large general shops. So pressing has the need of this highly skilled class of mechanic become that in spite of the profitableness of the second class, corporations now make every effort possible to encourage young men to advance past the mere routine of making goods. A number of large concerns are devoting a great deal of attention to the development and teaching of apprentices.

Apprenticeship.—The General Electric Company of Lynn, Massachusetts, about 1902 put into operation an apprenticeship system which has proven to be beneficial both to the firm and the employees. They organized a special department devoted entirely to the training of apprentices. This department was put under the direct control of a superintendent, who was especially qualified to teach young men the principles of their trades. The company also established class rooms in the factory in which the boys are taught drawing, and are given instruction in engineering science. The training received by a student at Lynn is so broad "that the graduate apprentice is prepared to fill a position as a skilled journeyman or as industrial foreman in any mechanical establishment." [1]

The Baldwin Locomotive Works of Philadelphia is another well-known firm which has established an apprenticeship system. They have not, however, set apart a separate school or department for the training of the young men. A learner goes into the various shops and departments and

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[1] *The Annals of the American Academy of Political and Social Science*, Vol. XXXIII, No. 1, January, 1909, p. 143.

gathers knowledge and experience from things as they actually go on in the usual course of events in the works. In order to provide for several classes of apprentices they have made provision for three classes of applicants.

Apprentices of the First Class.—The first class includes boys of seventeen years of age who have had a good common school education, and who bind themselves by indentures (with the consent of a parent or guardian in each case) to serve four years; to be regular at their work; to obey all orders given them by the foreman or others in authority; to recognize the supervision of the firm over their conduct out of the shop as well as in it; and to attend such night schools during the first three years of their apprenticeship as will teach them, in the first year, elementary algebra and geometry; and in the remaining two years, the rudiments of mechanical drawing.

Apprentices of the Second Class.—The second-class indenture is similar to that of the first class, except that the apprentice must have had an advanced grammar school or high-school training, including the mathematical courses usual in such schools. He must bind himself to serve for three years, and to attend night schools for the study of mechanical drawing, at least two years, unless he has already sufficiently acquired the art.

Apprentices of the Third Class.—The third-class indenture is in the form of an agreement made with persons twenty-one years of age or over, who are graduates of colleges, technical schools, or scientific institutions, having taken courses covering the higher mathematics and the natural sciences, and who desire to secure instruction in practical shop work.

The indenture or agreement in each case obligates the company to teach the apprentice his art thoroughly and to furnish him opportunity to acquire a practical knowledge of mechanical business. The firm is also bound to retain the

apprentice in service until he has completed the terms of the indenture or agreement, provided his services and conduct are satisfactory. In all cases the firm reserves the right to dismiss the apprentice for cause.

The rates of pay in the different classes are as follows:

	1st year per hr.	2d year per hr.	3d year per hr.	4th year per hr.
Apprentices of the First Class	7c.	9c.	11c.	13c.
Apprentices of the Second Class....	9c.	11c.	13c.	
Apprentices of the Third Class.....16c.		20c.		

In addition to the rates mentioned above, apprentices of the first class each receive an additional sum of $125, and apprentices of the second class an additional sum of $100, at the expiration of their full term of apprenticeship.

By the course of training provided for in this system, it is believed that a great benefit will accrue to the mechanic as well as to the employer. To young men who have received a thorough technical education, the two years' course in shop work is especially recommended.[1]

Mr. N. W. Sample, superintendent of apprentices in the Baldwin Locomotive Works, states that the system has proven quite satisfactory.

"Three years after the first indentured apprentice completed his term, there were employed over two hundred graduated, first-class, all-round mechanics capable of assignment to any shop, and of this number fifty occupied places of responsibility as heads of departments, foremen, assistant foremen, contractors, and leading workmen. It is no longer necessary to go outside of the works for any talent desired." [2]

The Westinghouse Electric and Manufacturing Company is another firm which is laying much stress upon the proper

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[1] *Circular No. 3, Apprenticeship System,* Baldwin Locomotive Works.

[2] *The Annals of the American Academy of Political and Social Science,* Vol. XXXIII, No. 1, January, 1909, p. 177.

development and training of young men for their works. They have two apprenticeship systems, that of the Trades and that of the Engineering. The former is designed for young men who have not had a technical education. The latter is intended for graduates of technical schools and colleges. The Trades Apprentices are recruited from young men between the ages of 16 and 23 years. All under 21 years must have their parents' or guardians' consent embodied in the agreement which is made with the company. The term of service for the Trades Apprentice is four years, while that of the engineering class is two.

The company is generous in its treatment of the men. They are given very fair remuneration during their term of service, and are promoted from task to task as their capabilities develop. The promotions are accompanied by graded increases in wages. The trades apprentices are started at 9 cents per hour, and at the end of each year receive an increase of 3 cents per hour until they complete their term. The engineering men are started at 18 cents per hour, for which sum they work one year of the time, or 2,740 hours. After this first year of service, they are remunerated at the rate of 20 and 22 cents per hour, the former rate being granted for the first six months of the second year, and the latter being for the next six months.

The firm takes care that the young men to whom they grant the privileges of apprenticeship have the fundamental training and native ability to make proper use of the opportunities. Those who desire to become enrolled in the work are obliged to make application in their own handwriting, and must tell their father's name, state his business, they must give their name, age, height, weight, educational and other training, the foreign languages they speak, the degrees they have received, and the schools or colleges they have attended, and no one is considered who does not submit a recent photograph.

While they are serving their time an exact record is kept of their conduct and performance within the plant; and, if they are trade apprentices, their outside night school work is carefully graded and recorded. They are marked for workmanship, personality, and outside class work. A young man has an incentive to do his best in every department; because, if at any time he becomes incompetent through neglecting his work or studies, or is insubordinate, he is liable to dismissal. Dismissal means he loses both a job and a chance to better his future condition. If he honorably completes the term of service, the firm in the case of trade apprentices presents a substantial reward in the form of $100 and a diploma, which tells the world that he is competent to follow some definite line of work. The engineering apprentices receive no gratuity, but obtain certificates.

Nothing so clearly indicates our progress both in the industrial and educational fields as do these highly organized apprenticeship systems. This development has taken place within the last ten years. Indeed it is not that long since apprentices in some places were started in at $2 per week, and raised a dollar or so every year until they were earning a weekly wage of $6 by the time their terms expired. In the older shops, his training depended very largely upon the caprice of his foreman and his own assertiveness. If he were wide awake and insistent upon getting acquainted with all classes of work which went on in the shop, he would get a good training. If, however, he were not a favorite or a forward kind of youngster he would frequently secure a poor training for a future career.

The writer knows of one plant which still has the old style of apprenticeship contract, and the trouble it has had to find competent foremen, gang bosses, and workmen is evidence that a far-sighted, generous policy is the most profitable.

Individual Ability.—No firm can hope to be successful if it is dependent upon unusual ability of any considerable

portion of its workers. A large number of firms whose work is of such a nature that a formal system of indenture is inadvisable or impossible have adopted the policy of supplying an understudy of some kind to every man who has charge of a department containing a number of men. This assistant or helper is expected to acquaint himself with all the duties of his chief, and is supposed to act in his absence. In this way the plant is never at a loss to fill any position which may be vacated in any department. One large organization engaging some 40,000 employees will not promote one from a lower to a higher position unless that same man has trained a subordinate to fill his position. This insures to the firm available workers for every possible position, and it also has a tendency to develop a very friendly feeling between the heads of departments and their assistants, because the departmental head sees that it is to his distinct interest to have capable subordinates.

Another firm takes the attitude of fearing the coming man. Every foreman or division head likes to impress all of the superior officers with the idea that, if he leaves, the department will suffer. In a measure he speaks the truth, because those individuals take care to have subordinates who possess few of the larger qualities needed by men of initiative. The firm as a consequence is terribly handicapped, and as is to be expected, the work in the departments is so unsatisfactorily performed that every few years there is a general "shake-up" in the plant, entailing the resignation and dismissal of a large number of the departmental heads. Thus the short-sighted policy pursued by every one in the plant to hold his job is the very thing that is hindering his personal advancement and the general prosperity of the firm. This concern has not paid a dividend on its stock for more than a half dozen years, while the former company's stock has averaged 7 per cent for a generation.

CHAPTER XV

THE PAYMENT OF THE WORKMAN

In order to get the maximum product from any set of employees, the manager must consider:

1. The best methods of keeping the men employed at their maximum limit while within the plant.

2. The best methods of making their work accurate.

When one establishes a wage scale he should have those two objects in mind.

The greatest incentive a man can have to work faithfully is to be paid according to some scheme whereby his remuneration is directly proportional to his output. How to establish a wage scale which will yield this maximum output for a minimum wage cost is a problem that has troubled managers for years.

The oldest scheme of wage payment is to pay the worker a certain fixed sum for the time he is employed in the plant. In the hands of a vigorous overseer thoroughly conversant with all the work in the plant, the time system proves satisfactory provided the plant is so small that the foreman in charge can keep in constant touch with all that is going on. From the employer's point of view it might appear that nothing can be more perfect than the time system of wage payment; because every increase in output that the man makes means an absolute gain to the owner of the plant. The curves $A\ A'$ in Fig. 24 show how increased exertion contributes to the profits of the firm; the employee gets the same compensation whether he does one piece or a hundred, while the employer can see with glowing satisfaction his wage cost per unit dropping downward. There is but one

difficulty with which the employer must contend in this remunerative scheme. The employee will not give his best efforts so long as added exertions do not bring immediate returns. The only tangible encouragement a man has in the time system is that his rate of pay will be increased from time to time as he demonstrates his worth. In a large shop it is impossible for a foreman to be in such intimate contact with all the men that he can make wage adjustments that will be strictly fair to each individual. It is hard to measure the efficiency of a man by his general attitude or by his talk. Some of the best talkers and apparently most industrious workers may be confirmed loafers and the least efficient men in the firm's employ.

The only practicable way of establishing a satisfactory time-rate system is to divide the men into groups or classes and fix a maximum and minimum rate for these classes. If a man is valuable he may get his wages raised to the maximum within the class, or he may be advanced to another class. The wages are fixed by bargain between the men and the employer. This bargaining may be done either collectively at the dictation of a labor union, which fixes minimum wage rates, or it may be done by the individual workmen fixing their wages with the foreman. At best, the wage adjustment is largely guesswork so far as rewarding individual men for what they do.

Unless there is some means of measuring what a man does, it is unsafe to depend upon personal likes and dislikes. Here lies the inherent weakness of the time-rate system. A foreman will often raise wages not because a man actually produces more, but because he thinks the man more efficient. Managers in plants have long appreciated the fact that there should be a different method of fixing standards of wage payment than on the basis of personal conjecture.

The average man is not inclined to overexertion. Frequently his chief aim seems to be to do the least amount of

work necessary to keep from getting discharged or being reduced in pay. Foremen are much annoyed and firms lose thousands of dollars through the idleness of men from one cause or another. A great deal of this lack of energy on the part of the men is not due to wilful idleness but to oversight on the part of the foremen. Men will frequently get a job completed and wait with perfect complacency until the foreman comes to them with another task. In some poorly run shops men waste as much as half a day waiting for the foreman to find out that they are ready for a new job. There are also other kinds of time losses. Men will frequently wilfully kill time in order to make work last. Machines will not be run to their maximum capacity because to do so will finish a job so long before quitting time that it will be necessary to lift off the piece and adjust another about the time the whistle blows. One will sometimes see men in day-rate shops actually make their machines run without doing anything at all in order to appear to be working and so do away with the necessity of changing a job at some inconvenient time. Managers of plants are not ignorant of these conditions. The wilful dishonesty and lack of willing cooperation on the part of the employees have made the daily wage system a poor means of remuneration for many kinds of work. Wide-awake men rightly reason that if a scheme could be devised by which workmen lose money for idle time, they would not be so inclined to sit with bovine patience until their foreman finds them out of work and starts them on another task, neither would they be apt to waste time wilfully in order to start new work at a more convenient season or to save a job when work is getting low in the shop.

It is rational to assume that the remuneration for labor should be on the basis of all ordinary commercial transactions, that the man should be paid for what he does, that compensation should be by the piece-rate system. There can be no more effective way to prevent idleness, because the

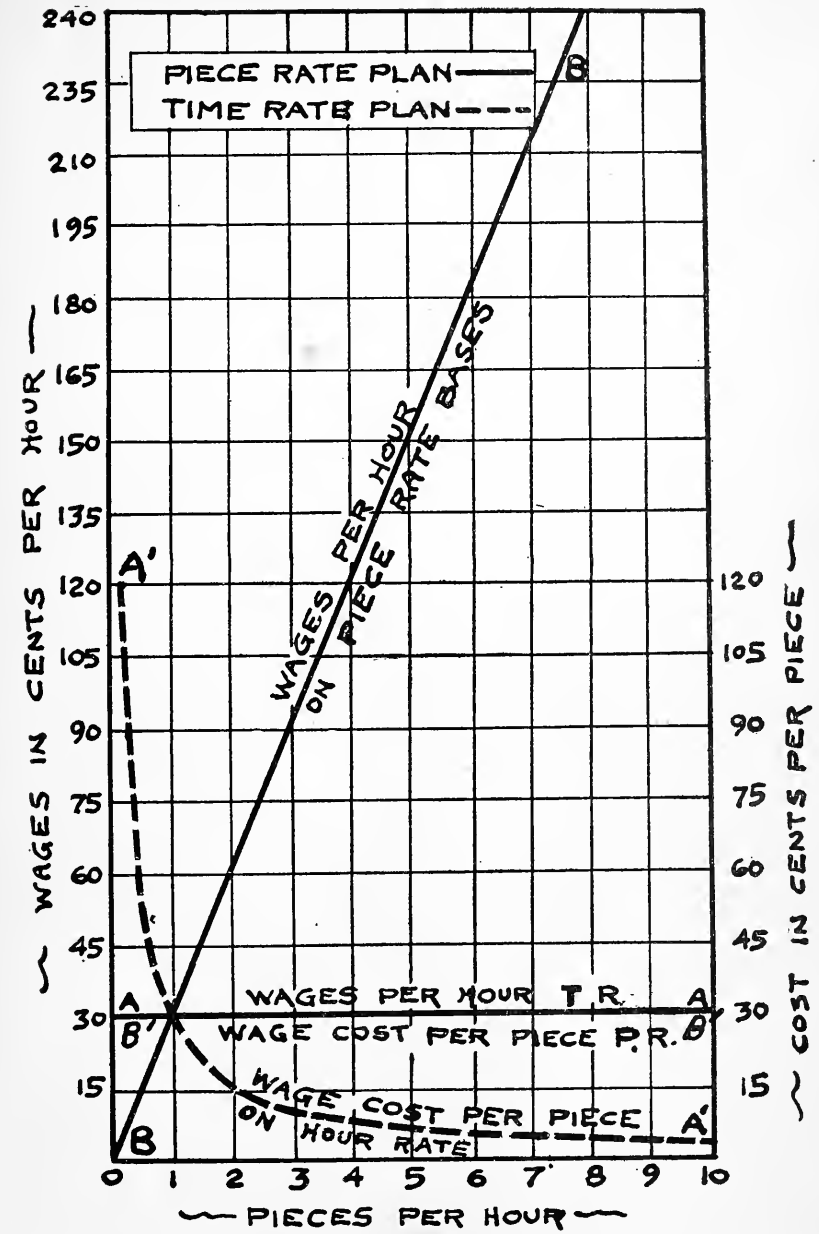

FIG. 24.—Comparison of the Time-Rate and Piece-Rate Systems.

idler is fully as much a loser as the firm. Viewed from the workman's standpoint, there can be no more profitable means of remuneration. Fig. 24, on lines *BB*, shows that on the piece-rate system of wage payment a man automatically raises his hourly rate by increasing the output. The firm apparently does not gain directly from the increased effort, as is shown by the fact that the wage cost per piece is a constant quantity. (See lines *B′ B′*, Fig. 24.) From the diagram one would conclude that the piece-rate system of wage payment would be a system strongly advocated by the workman. The opponents of the piece-rate system are not the employers, but the men. Their opposition is based upon good reason, and yet, from the employer's point of view, it is almost impossible to eliminate the objection. To fix piece rates one must be guided by the capabilities of the employees. When managers introduce the scheme they try to be fair to the men and estimate the time it will take to perform certain tasks on the basis of previous time records made by men employed on the day-rate system. These records are from the very nature of the case inaccurate, and it is found invariably that nearly every one underestimates the workman's efficiency when he has an incentive so great as that offered by the piece-rate system. In some cases the output of the workman will increase seven and eight times his estimated maximum.

Under these conditions the manufacturer finds he is often paying extravagant prices for labor which is either unskilled or semi-skilled in type. In these competitive days, he cannot afford to pay exorbitant daily wages to men whose training is of a low order, because his competitors will soon adopt a daily wage or a piece-rate schedule of a very much lower wage standard. The result is that the piece-rate system of wage payment in industries, which have not been thoroughly standardized and developed, has been found exceedingly unsatisfactory, because the workmen consider it unfair to cut

their rates, and the managers find it almost impossible to establish a rating which will be satisfactory to themselves and to the employees without considerable adjustment.

The breakdown of the piece-rate system is due to the fact that it is impossible to adjust rates without friction. The men consider every reduction of the piece rate an illustration of the employers' greed, while the employers feel that the increased output is another example of how grossly employees have deceived them in the past in order to mislead them into paying excessive wages. Both sides feel disgruntled.

Employers who have experimented with this system and have discovered the skill a laborer possesses, have endeavored to apply the theory of giving a large incentive to some one who can guide and direct the men and yet pay these workers a day rate. There are plants in this country which apply this scheme, and call it the Contract System. The foremen in charge are given a certain price for the work they do, they hire and direct the men, usually paying them on a day basis, and fixing their wages at the lowest possible point the men will agree to take. Under the contract system of working, the foremen have their income based upon the work they can get from these men. The scheme has a tendency to develop a body of alert overseers who are always after the men to see that they are not wasting time either through laziness or by incompetence. The system when it operates makes men work, but it has the unpleasant disadvantage of developing slave-driving habits. Many men will not stand for such treatment; and unless the work is of such a nature that a rather low type of worker can be employed and taught the tasks to be done, the company is liable to have a great deal of trouble with its labor under this contract system, although in some plants it has worked successfully for many years.

Mr. Henry R. Towne, a number of years ago, conceived a scheme which has had a profound influence upon pay systems, because he introduced an incentive rather than a coer-

cive process to get men to increase their exertions.[1] His scheme is briefly this—find out what has been the average cost for a given amount of output in the best year before he introduced the system. With this as a unit he determines what the labor cost for the same quantity has been for each succeeding year. The difference in labor cost between the two gives him the savings made for the firm by the extra effort of the labor force. This saving he distributes in the following way: 50 per cent is retained by the firm, 10 per cent is given to the foremen in charge of the work as an inducement to them to get men to increase output, 40 per cent he distributes to the gang bosses and workmen throughout the plant on the basis of their annual wages. The remuneration is given at the end of the year or at the end of some considerable length of time shorter than a year.

This sharing of the gain with the men has in it a number of defects, the most important of which are:

1. The reward is remote.

2. The method of division is not likely to encourage great activity because the men do not receive shares in proportion to their individual efforts.

Some writers have criticised the system, because it makes the men share gains which they say may be due to improved methods of work or to better management. There may be some basis for this statement, but Mr. Towne's paper distinctly stipulates that the books shall be so kept that any improvements in management will not be shared by the workmen save in so far as they actively assist in the work. The paper specifically notes that it is only fair to share with the operatives the savings which their activity makes for the firm.

The remoteness of the reward and the method of division

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[1] *Transactions American Society of Mechanical Engineers*, Vol. X, p. 600, No. 341, "Gain Sharing," by Henry R. Towne.

are, however, serious objections, and these Mr. F. A. Halsey circumvented when he presented the premium plan of remunerating labor.[1] Mr. Halsey believed with Mr. Towne that the workman should be rewarded only in so far as his actions lower production costs. He, however, appreciates the fact that a much better incentive will be given to men if they are paid at once their exact share of all the profit they make. His scheme is briefly this:

A man is given a certain rate per hour. A piece of work is assigned to him which will be allowed a certain number of hours time in which to be done. If the man performs the work in a shorter time, he will be given a fixed percentage of the value of the time saved. This extra sum will be paid to him as a premium to his wages, and on that account the Halsey scheme is called the Premium Plan of Remunerating Labor. The idea of the scheme is to establish the shop on a piece-rate system, in which the men will be guaranteed a certain daily wage. If the management has fixed the price of the unit of work performed at too high a figure the workman will share his extra productive value with the manufacturer in a manner that will not require the cutting of the rate. In a word, by dividing the gains due to his extra productivity, both the manufacturer and the worker profit, and the worker will have no reason to limit his output because there will be no rate cutting.

The lines AA, Fig. 25, show how by this system a man increases his hourly wage in a very material way by increasing his productivity. At the same time he cuts the unit price per piece considerably for the firm. (See lines $A'A'$, Fig. 25.) The figure shows just how Mr. Halsey manages to make unnecessary any cuts in the unit rate. By his sys-

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[1] *Transactions American Society of Mechanical Engineers*, Vol. XII, p. 755, "Premium Plan of Paying for Labor," by F. A. Halsey.

tem, the workman by increasing his wages actually cuts the cost of production. His only method of obtaining a big reward is to cut the unit cost. Thus the employer has a decided advantage. If we look at the other term of the contract we find that the workman is guaranteed a standard daily wage, so that he can feel that he is not on the piece-rate sys-

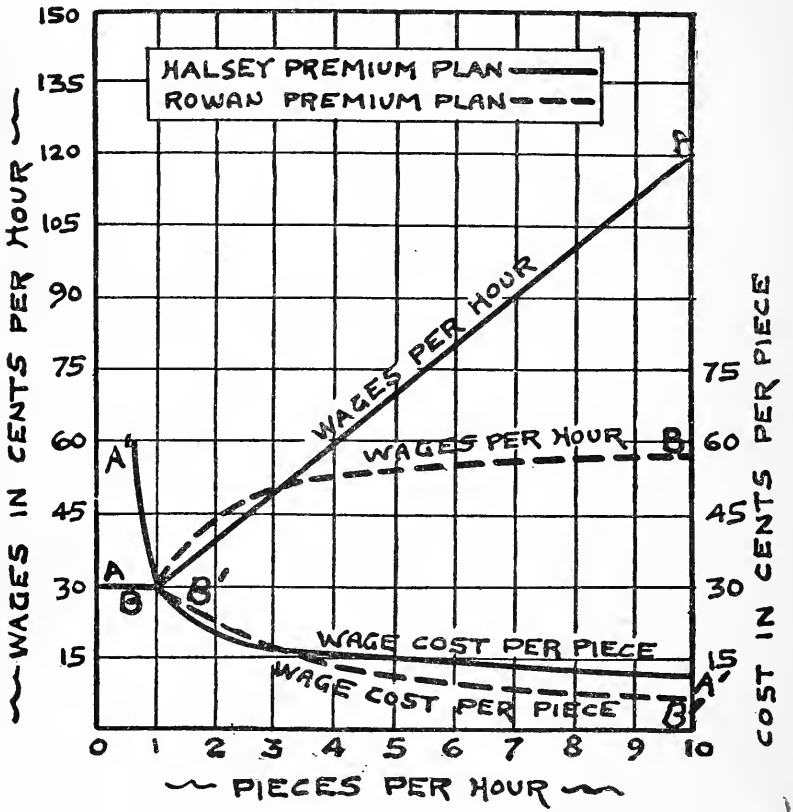

FIG. 25.—Comparison of Halsey and Rowan Premium Plans.

tem. If the price per unit has been set too low, he is not compelled to overexert himself in order to make a fair daily wage.

The advantages of the Halsey system are:

1. The men are encouraged to produce more by being rewarded in proportion to what they do.

2. The reward is immediate and substantial.

3. The employer, in sharing the gains of the extra exertion on the part of the worker, does not have the necessity of cutting the rate in an arbitrary manner, hence the workman's mind is relieved of the fear of having his wages reduced arbitrarily.

A British modification of the system was put into operation by David Rowan & Company. Mr. Rowan's wage curve is plotted *B B* on the same diagram (Fig. 25), which shows Mr. Halsey's premium plan, while the Rowan piece cost is shown as line *B′ B′* on the same diagram. According to Mr. Rowan's idea, if a job has been allotted too much time, even with the Halsey system, a man may get a remuneration out of all proportion to the value of the work. For example, if a man should be allotted one hour to do a piece of work worth 30 cents, and if he should increase his productivity ten times, with the Halsey system he would get $1.20 an hour. This is considerably better for the firm than his hourly rate would be with straight piece work. The latter cost would be $3 an hour. (See Fig. 25.) Mr. Rowan believes, however, that even Mr. Halsey's scheme is too extravagant in its reward, so he devised a plan of so adjusting the premium that every increase in wages should be equal to the percentage the operator saves on the time. For example, if a job is allotted one hundred hours and the man's rate is 30 cents per hour, the cost of the work would be $30. If he does the job in ninety hours, with his hour rate 30 cents, the time wages on the job would be $27. He has saved, however, 10 per cent of the time, and gets a 10-per-cent increase in wages on the actual time cost. Should he do the work in eighty hours, the time rate would be $24. Twenty per cent time saved on $24, the time cost, would be $4.80. A comparison of the two tables will show the wage scale (wages rate 30 cents per hour) as worked out by the Halsey and the Rowan methods.

COMPARISON OF DIFFERENT METHODS OF CALCULATING PREMIUMS.[1]

Halsey's Method.

Hours Allowed.	Hours Taken.	Time Wages on Job.	Premium Earned on Job.	Total Labor Cost.	Workman's Rate per Hour.
100	100	$30.00	$0.00	$30.00	$0.30
100	90	27.00	1.00	28.00	.311
100	80	24.00	2.00	26.00	.325
100	70	21.00	3.00	24.00	.343
100	60	18.00	4.00	22.00	.366
100	50	15.00	5.00	20.00	.40
100	40	12.00	6.00	18.00	.45
100	30	9.00	7.00	16.00	.533
100	20	6.00	8.00	14.00	.70
100	10	3.00	9.00	12.00	1.20
100	1	.30	9.90	10.20	10.20

Rowan's Method.

Hours Allowed.	Hours Taken.	Time Wages on Job.	Premium Earned on Job.	Total Labor Cost.	Workman's Rate per Hour.
100	100	$30.00	$0.00	$30.00	$0.30
100	90	27.00	2.70	29.70	.33
100	80	24.00	4.80	28.80	.36
100	70	21.00	6.30	27.30	.39
100	60	18.00	7.20	25.20	.42
100	50	15.00	7.50	22.50	.45
100	40	12.00	7.20	19.20	.48
100	30	9.00	6.30	15.30	.51
100	20	6.00	4.80	10.80	.54
100	10	3.00	2.70	5.70	.57
100	1	.30	.297	.597	.597

The reader will observe that while the Rowan plan compared with the Halsey method does prevent excessive earnings on the part of the employee when he multiplies his output many times, it on the other hand gives a decidedly

[1] "Trade Unionism and Labor Problems," by John R. Commons, p. 287.

greater reward to the workman until he more than doubles his productive capacity. Is this a desirable characteristic of a wage system? Does not the Rowan Premium tend to encourage the workmen to remain at a lower level of efficiency than the Halsey Premium? To be perfectly fair to Mr. Rowan, it should be stated that his rate is adjusted for the purpose of making special cuts unnecessary. If a man loiters about his work when the rate is being set, he cannot reap too great a harvest by "rushing." The scheme certainly does act automatically in reducing output cost, but it seems highly probable to the writer that men who work under it would be somewhat inclined to "nurse" their jobs when they found that their added exertions increased their wages so slightly as the system does in the later stages.

In 1895, Mr. Fred W. Taylor read a paper before the American Society of Mechanical Engineers, in which he recognized the advantages of the Halsey system and its superiority over any previously proposed scheme, but pointed out that it has one very grave defect—while it encourages the workman to do good work, it gives only a passive incentive by not punishing him for not doing his best. In other words, the Halsey system permits men to gather premium for work done, but it does not necessarily stimulate a man to produce his utmost. In order to introduce this element, Mr. Taylor proposed a scheme of wage payment which both punishes and rewards, and which he calls the differential piece-rate system. According to this plan, a man is rewarded only after he attains a certain fixed standard of work. If he does not accomplish the job in a given time, instead of being paid an ordinary piece-rate price, he is paid a piece-rate price considerably lower than the one paid if he does the work within the stipulated period.

If the usual output of a 30-cent-an-hour man in an ordinary shop is one piece in an hour, Mr. Taylor would by his timing process find that an individual working at his maxi-

mum rate on every part of the job could accomplish three pieces in an hour. He would then fix his rate as follows: Three pieces in an hour would be made the standard. If a man could perform three pieces an hour he would get, not as he would get in the day-rate shop, thirty cents an hour, or ten cents a piece, but fifteen cents a piece, or some similar amount, for each piece performed, so that his hourly rate, if

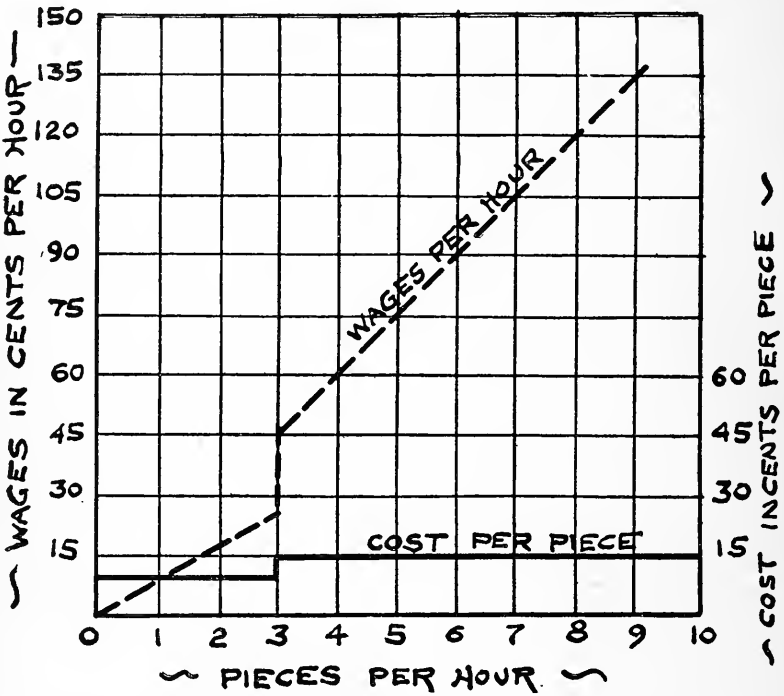

FIG. 26.—Taylor Differential Piece-Rate System.

he reached three pieces in an hour, would be forty-five cents. If he performed more than three pieces in an hour, say four or five, he would still get 15 cents a piece for every one performed, so that the workman, as shown by Fig. 26, would raise his wages by a fixed amount for every piece finished. If, however, he could not make three pieces within the allotted time, he would not get 15 cents a piece, or even 10 cents a piece. He may be given but 8 cents for every piece made

below three pieces. With such a scheme one can easily see that it is very important indeed, from the workman's point of view, to perform a large amount of work in a day.

This plan of reward differs from any of the others in another essential, aside from the differential piece-rate idea, viz.: The time allowed to do the job is very accurately determined. The superintendents of the works make a careful study of the exact time it needs to take to do the jobs, working in the quickest known way, and the workmen are allowed a period just sufficient to permit them to perform the task in the most approved fashion in which it can be done. Thus there are two ideas involved in Mr. Taylor's differential piece-rate system: (1) a punishment for one who does not perform the task, and a reward for the one who does, which is the method of payment idea; and (2) the workman has accurately determined for him by his superiors the time it should take to do the work. In a subsequent paper entitled "Shop Management,"[1] Mr. Taylor discusses in detail his method of ascertaining the time it should take a workman to perform his task. Every job is divided into its elementary operations; and an attendant, by means of a stop watch, observes the time in minutes and seconds it takes a good workman to perform each part. The total time of the job is then fixed by adding together the time it takes to accomplish all of these elementary steps. With the time thus determined, a task is given which will keep a good man busy in performing, and yet which is within his possibilities. Mr. Taylor emphasizes the idea that the task must be so hard that only a first-class man can perform it. He gives high wages and secures a low labor cost by accurately determining the maximum possible output of a workman, and compelling him to reach that standard. He utilizes the hitherto un-

[1] *Transactions American Society of Mechanical Engineers*, Vol. XXIV, pp. 1337–1480.

alized possibilities of the laborer by learning what those possibilities are, and giving the reward only if they are attained.

The Halsey system, as criticised by Mr. Taylor, is defective, because it does not give the workman a definite goal to reach, hence the high wage paid does not reduce the output cost as it should.

In the *American Engineer and Railroad Journal* for February and December, 1906, there appeared two articles

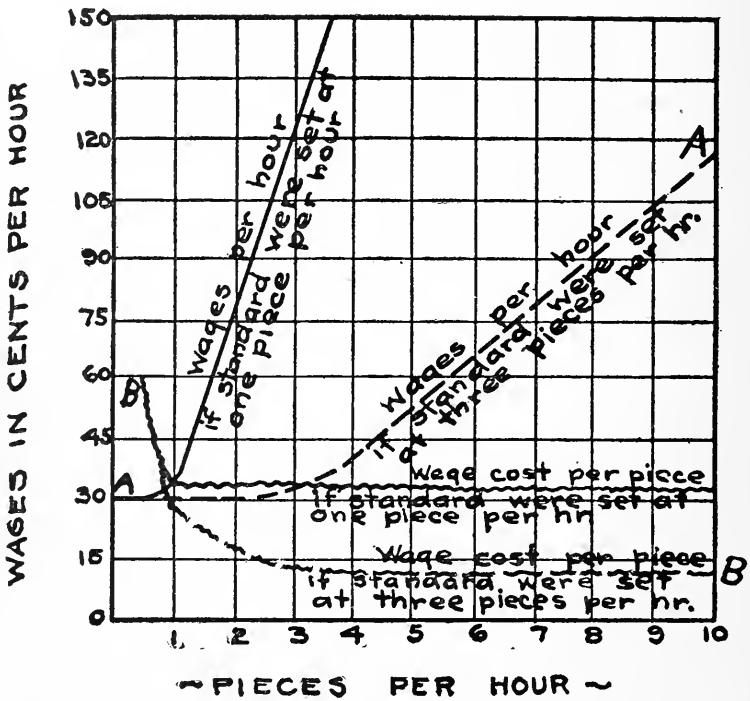

FIG. 27.—Emerson Differential Piece-Rate System.

descriptive of the Santa Fe's shop-management scheme. The first article is entitled, "Shop Betterment and the Industrial Method of Profit Sharing," by Harrington Emerson. The second article is entitled, "Betterment Work on the Santa Fe," written by the staff writers of the *Journal*. These two articles have been the source of much comment, and of articles in other magazines. Mr. Emerson has devised a piece-

rate system, which in many respects is analogous to the Taylor plan. He determines from previous shop records, and by a careful study of the best possible ways of performing the work, how long it should take to do each task as it comes into the shop. His scheme of remuneration is, however, different from Mr. Taylor's as regards the basis of payment. After determining the minimum time it takes to perform a task, a man is paid a fixed daily rate of say 30 cents an hour until he performs two thirds of the standard task. If he performs the standard task, or 100 per cent, which in our illustration would be three pieces in the hour, he is given an extra reward of one fifth of the regular wages for the operation. If he performs more than two thirds of the work, but less than the standard, he is likewise paid a gradually increasing bonus, as shown by curve *A A* on Fig. 27. If the workman can perform more than three pieces in an hour, he is paid the high price per piece for every piece he makes over the standard. The Emerson system differs from that of Mr. Taylor in one respect. It is not a piece-rate system until the man performs at least two thirds of the standard task.

Between the Halsey system and the differential piece-rate system, as developed by Messrs. Taylor and Emerson, there is another plan proposed by Mr. H. L. Gantt, called the "Bonus System for Rewarding Labor."[1] Mr. Gantt's scheme differs from the differential system in that it is not a piece-rate system, yet it is like the Taylor system, in that it does set a definite task for the person to perform. If the individual performs the task within the given time, he is paid his regular hourly rate and a certain stipulated bonus. Every job is allotted a certain amount of time; if the man performs the task within this time, he is given the bonus, and as soon as he finishes one job he is given another, to which he is like-

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[1] *Transactions American Society of Mechanical Engineers*, Vol. XXIII, 1902, p. 341.

wise allotted a definite amount of time. The result is that if a man in the course of a day doubles his output, he will get a day's wage plus the bonuses, which are attached to the separate jobs he has performed. If he fails to do the work within the allotted time, he gets only his day's wage.

As a matter of fact, it makes very little difference which system of wage payment is used. There is no reason why the Halsey system need be a "drifting" system, as termed by Taylor. The thing that makes the differential piece-rate system effective is that the manager of the shop determines the time that should be taken to do the work, and fixes his differential rate accordingly. Should the manager of the plant, where the premium system is applied, take the same means to determine the minimum working time, the premium system could be adjusted equally well. There are shops which have tried both the premium and the differential piece-rate systems; and, after giving both a fair trial extending over many months, found the premium plan considerably more satisfactory. On the other hand, there are shops which have ultimately decided upon the differential piece-rate system. Indeed, the method of payment is not so important, if the concern can find a scheme that will justly determine the possibilities of a worker. The system of wage payment for this purpose is a secondary matter. The method of obtaining the possible speed at which a worker can produce is the real problem of management, and the real object of all wage-payment systems should be to reward him in such a manner that he will produce this maximum.

Mr. Taylor suggests his unit-time study method to obtain the speed possibilities of the man; Mr. Halsey gets his data by studying shop records and carefully observing the men. Both schemes have produced good results under different conditions. Generally speaking, the unit-time study system is successful in shops which handle contracts of a more or less unvarying character, and are not compelled to follow exact-

ing requirements. In one shop of a miscellaneous type which handled work that had to be exceedingly accurate, the unit-time study system, after a fair trial extending over many months, proved a most dismal failure. When men tried to make the calculated time, they spoiled the work. In another shop it has proven successful, yet the same man who made it a success in the one shop, failed to make it a success in the other, and he had the cooperation of the management in both cases. The cause of the failure in the one shop was the exacting type of the work, and in the other the success was due to the rather crude character of the output.

In the shop where the differential system failed the premium system was next tried, the time being predetermined by previous shop records, and by keeping after the men; and the scheme was successful, the very scheme which Mr. Taylor so severely condemns.

In his paper, Mr. Taylor emphasizes one thing which should not be passed over without some comment. He does not advocate the paying of high wages so much as he urges the paying of wages which are considered high by the average workman of the grade he employs. His plan is to teach a low-grade man to do work which would otherwise be given to a highly skilled man. "The writer" (Mr. Taylor) "goes so far as to say that almost any job that is repeated over and over again, however great skill and dexterity it may require, providing there is enough of it to occupy a man throughout a considerable part of the year, should be done by a trained laborer and not by a mechanic. A man with only the intelligence of an average laborer can be taught to do the most difficult and delicate work if it is repeated often enough, and his lower mental caliber renders him more fit than the mechanic to stand the monotony of repetition."[1]

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[1] *Transactions American Society of Mechanical Engineers,* Vol. XXIV, p. 1347.

Care must be taken not to carry that policy too far. There are concerns in this country employing this means to have their work performed. One plant has advertisements in papers every once in a while for men. They employ a high-salaried man, who is nominally in charge of a large department, but whose work is delegated to an assistant. The chief of this department spends so much time getting people that he is not in touch with the work as he should be. He gets men at a low price, and just about the time they are trained they leave. The plant is in a state of unrest and irritation at all times, due to the fact that about one third of the working force is always just learning, and is making mistakes that cause the gang bosses and foremen to be blamed for not looking after the men. These, in turn, vent their spleen on the man who ignorantly makes mistakes. This concern, however, looks with pride upon its average wage rate per man, and fully believes that it is carrying out a sound labor policy. On the contrary, the low average per man being paid for work regarded elsewhere as safe only in the hands of skilled men is costing the firm dearly in spoiled work.

In order to determine the best way to carry on a plant, one should not be guided by any set of opinions or by any one system. The manager should know the men's records, the amount of material that is used and wasted, the amount of defective products returned by purchasers, and the performances of the machinery. These are the things which his shop accounting system should tell, as the following chapters will explain.

CHAPTER XVI

RECORD OF THE WORKERS

If the management establishes a fair wage scale, it can enforce the performance of good work by discharging incompetent workers, because well-paid men want to do good work in order to hold their jobs. If the wage scale is unfairly low the workmen will be able to find better, or at least as good, employment elsewhere, so that discharge is no threat to compel good work under these conditions. Assuming a fair wage scale, how can the management enforce the performance of accurate work? Obviously, there is but one way, and that is to punish the workmen who turn out poor work. Good management dictates more than a policy of finding out what each man does. To have good work turned out as a matter of course, is the goal for which all concerns should strive, and this can be done only by getting rid of the poor men and by seeing that no incompetent men are re-employed. To keep good men, rewards must be given either by promotion or advances in wages from time to time. To reward the right employees, there must be an accurate record kept of the men from the time they enter the plant until they leave it.

For a small shop, a foreman can be secured who may be entrusted with determining the efficiency of the employees, because if he is in the habit of being easily deceived by incompetent assistants, the defect soon manifests itself to the management. In large plants, however, good foremen are frequently embarrassed by poor workmen; and, many times, poor workmen, after being discharged from one department, find employment in other departments until their delinquen-

cies are again discovered. If insufficient record is kept of their service in the plant, they may, after a time, be re-employed in the department in which they first demonstrated their inefficiency, and even under the original foreman.

No ordinary person, having under his constant guidance three hundred to four hundred men, can keep in mind all past employees. It is not hard to discharge a man if he displays inefficiency, but by the time he has proven his incapacity, the firm loses money, and the man himself is being done an unkindness by being given even passive encouragement to work in a field for which he is unfitted. It is better for him to be compelled to discover a place where he will be serviceable, or to find an occupation more suited to his ability.

Some few years ago, there was a plant which did not believe in keeping records of its employees. The foreman hired men whenever he needed help. In one instance, an employee was caught idling and was discharged. He lost half a day, was re-employed in another department the next morning, and at the end of the week, in spite of the lost time, he received more money for the same work than he would have had with his old job under the other foreman. The second time he "soldiered" as much if not more than the time before, but was circumspect enough to be employed very assiduously whenever the officials approached his vicinity.

Another organization transferred men from one department to another without ever recording such changes in the main office. A vacancy once occurred in a department wherein a man desired to be located, and he asked permission to change. The boss signified his consent by saying, "All right, I'll send your time to the main office." A week later the pay envelope showed that the man was paid for working in two departments at the same time. To cap the climax, when he reported the overpay, he was reprimanded by his former boss, who said, "You might have kept quiet and not

have gotten me into trouble. It didn't do you any good to squeal." And it surely did not, for the man was now compelled to wait two weeks for his next week's wage, the paymaster remarking that it took so much time to make the correction.

In order to make the foreman responsible for good work, both in quality and in quantity, the manager should take pains to supply him with efficient men, and to do this he should have a working scheme that will keep proper record of the employees. In a large concern, this can be done to best advantage by establishing a labor bureau. A small concern can safely let the time department keep a card-index record of the men.

The problem of the labor-employing bureau may be divided into several parts:

1. To select and employ the proper laborers for different duties.

2. To keep record of the employees who are still employed, with their status as workers.

3. To keep record of all people who have been employed at any time with reasons for their dismissal and their record as employees.

The best basis for good judgment is accurate knowledge. If an employer secures accurate knowledge of an applicant for a place before he hires him, he can save himself much trouble and some expense. There are several things a manufacturer should know at once about an employee.

1. Has he any constitutional weaknesses or injuries?
2. His approximate age.
3. His educational qualifications.
4. His experience.

The first three can be gotten pretty accurately by combining answers on the part of the applicant with personal observation. The fourth one is not so easily determined by asking questions, especially if the applicant is inclined to be un-

truthful. Many men apply for jobs for which they are unfitted or have had a very meager preparation. In one shop an ex-weaver secured a position as a steamfitter by merely stating to the hiring clerk a lot of hypothetical experience. As a matter of fact the young man did not know the difference between a pipe-wrench and a pipe-cutter, but he held the job for six months before he made too many blunders.

The safest way to determine a man's experience is to have him state the names of his former employers and people to whom one can be referred who can tell about his efficiency and conduct from actual experimental knowledge.

Considerable thought should be put upon the framing of the questions on the application blank. For instance, in asking for the practical experience the applicant should be requested to state the trade or occupation learned, the length of time in service, and what was done while in service. In this way the applicant will give definite information concerning his work and will not have a chance to branch off into meaningless generalities. Every question should be so framed that the answer to it must be brief and give definite information about one thing.

Some firms require the applicant to state age, whether married or single, whether he uses drugs, liquor, or tobacco, whether he belongs to a union or not, whether he is a citizen of the country, if he knows anyone in the plant, why he left his former place, the number of people depending on his wages, whether he speaks English and can read and write, what wages he expects, what he previously earned, does he look for further advancement, why he wants to be employed by that particular plant, and sometimes even other questions. One large concern asks no less than forty questions of every prospective employee. When one goes to that extent he is getting data which even if truthfully given would be unnecessary for any but the most unusual conditions. The data, however, cannot be depended upon after it is obtained.

Men, especially those in middle life, are very apt to misstate their ages. Several years ago a large concern determined to find out the ages of all of its employees, both those who had been long in service and those who were just being engaged. In hardly any case did the men state their exact age. The younger men overstated their age from one to five years, and the older men understated their age five years and more. In one case a man of more than sixty years told the clerk, "I am forty-three, and if you come around thirty years from now I'll still be forty-three."

Men resent questions of an inquisitorial nature. They rarely object to stating whether married or single; but when asked why they want to be employed in the plant or whether they expect any advances in wages, they feel they are being asked what a workman once called "fool questions anyway."

Much more information can be obtained about the man by looking up references. Some firms make it a point to send out blank forms to previous employers of an applicant whom they contemplate hiring. Others look up the references of every man who applies, so that they will have a trustworthy list of available candidates. The letter seeking information about the employee should be framed in such a way that the former employer can answer very briefly and definitely questions which will give one a very good idea of the capabilities and personality of a man. One form of a letter of this character is shown below.

DEAR SIR:

..... has applied for a place as ..... and has given your name as reference. Will you kindly answer the following questions regarding ....., and if there is any other information relating to him which is of interest, we shall be indebted to you for it.

1. How long was the above man employed by you?.....
2. In what capacity?.....
3. What was his rate per hour?.....
4. What advances did he get, if any?..... .....

5. Is he a good mechanic?.....
6. Are his habits good?.....
7. Is he regular in attendance and industrious?.....
8. Why did he leave?.....

Any information you give us will be treated as strictly confidential, and we shall be glad to answer requests of a similar nature regarding men who give our name as reference.

Very truly yours,

.....

This letter embodies questions which can be accurately answered with little trouble on the part of the individual who receives it. Some officials object to telling the public or business rivals what wages they pay their workmen. If experience shows that firms are unwilling to state the wages they have paid to past employees it is well to omit the question, and in fact all questions which they believe another company would not care to answer. The reason for leaving out such questions is that if there are too many objectionable requests there is a strong probability of the letter being ignored.

After one has obtained full information concerning the man, the next step is to keep a record of him as a worker. No recording scheme is of value unless it records actions as well as opinions. By this is meant that one of the most unsafe bases for judgment of a man's ability is what some individual thinks of him, unless the estimate is supported by evidence which shows the basis for the opinion.

The scheme which keeps record of the employees should do two things. In the first place, it should keep accurate record of what each person is doing so as to enable the foreman and other officials to place the men to the best advantage in the plant, and in the second place it should make it impossible for men to be put on the pay-roll who are not doing the work they are expected to do, or who may not be in existence at all.

A good employee must at least:

1. Be regular in his attendance, prompt in his appearance at starting, and faithful in his stay in the plant.
2. He must be diligent while within the plant.
3. He must be efficient.

It was shown in the previous chapter how the plan of wage payment develops the diligence and efficiency of the employee, but no matter what the wage scheme is, unless it has back of it some recording device to keep track of what a person is doing, it is impossible to gather data for the establishment of a good wage system, or to determine the cost of the article; and it is likewise impossible for the management to ascertain who are the good and who are the poor employees. A man is a good man for the firm if his average record is good, and a poor man for the firm if his average record is poor. The basis for determining his standing should be, "What has he done?"

Foremen are very apt to make wrong estimates of men, because they do not know their averages of efficiency. For example, in one place there is a bright, capable man who has on numerous occasions, in face of considerable difficulty, erected engines. His work has always been done with few men, and these not of the best, yet he has not made a serious mistake in the erecting of several engines. There is another man who on two separate occasions was likewise given some engines to erect. On these two occasions it happened, through laxity on the part of the shop management, that he was able to borrow men from other gang bosses, and the engines he had to erect were of such a nature that he could use nearly all the temporary bolts and other material which the other gang boss had been compelled to collect in order to erect some previous machines. The first man's ingenuity in gathering material enabled the second man to take advantage of these conditions, and in addition he used some laborers who were not properly charged to the job. In the

course of the erection he made a great many mistakes, had holes drilled in the wrong places, which made it necessary to have them tapped out and filled with plugs, he did nearly twice as much actual work in getting the cylinders and housings in the proper place, and his work all through was decidedly that of an amateur. Nevertheless his engines were done in a week's less time than were the other man's. He had established for himself a record in the plant, and when there was an opening for advancement he was given precedence over his rival. Workmen in the humbler positions are sometimes compelled to submit to such conditions. The foremen do not mean to be unjust. They cannot be altogether blamed for advancing the wrong man, when that person makes a spectacular showing. In the case above cited, if there had been exact time records kept of all the time expended on each engine, there would have been a considerable showing in favor of the first man who did not get the reward.

There is nothing so fatal to the discipline of a plant nor so disastrous to its smooth and profitable working as to have a body of men irregular in their appearance, who come late and go out at odd times.

Efficiency is, to a great extent, a matter of faithfulness; and, if a firm insists upon regular and prompt appearance, it is paving the way for good work. There is only one way to stop irregularity—make it unprofitable. If a firm weeds out the non-dependable individuals, it will, before long, develop a good working organization. To weed out these undesirables one should have an accurate record of the entering and leaving time of all the workers in the concern.

One of the most effective devices of time recording, and the one first adopted, is the time check. This is used in a variety of forms.

1. The in-board out-board form. At the entrance of the works are placed two boards, one marked "out-board," placed near the gate, and the other marked "in-board,"

placed farther toward the work rooms. Every man is assigned a numbered check, which hangs with the corresponding number on one or the other board according as he is in or out of the works. While the men are filing in, taking their checks off the out-board and hanging them on the in-board, a watchman stands near by to see that no one takes other than his own check. The gate is closed as soon as the signal for starting work is given, so that no one can get to his check after starting time without calling the timekeeper's attention to the fact.

2. A modification of the above scheme is to give the men actual possession of the check, which they drop in a box on entering the works. Obtaining the time record by either method is a simple matter. After the plant is started, all the checks are in, and the timekeeper makes a record of the numbers. In the second plan he takes the checks into the work-rooms and returns them to the men. In this way he comes into actual contact with each workman, so that there is no possible means by which one man can drop another's check into the box without being detected.

3. The third plan dispenses with the check. The workman is given a number, which he must announce as he enters a specified gate. A clerk at the entrance crosses off the number as the employee calls it out. With this scheme, it is impossible for a man to give more than one number, and the clerk has an immediate record of the men who are in the plant.

4. While these schemes are effective for plants of moderate size, or where the work-rooms are close to the entrance, they fail to be thoroughly satisfactory when the departments become scattered over a large area. Unless there be some kind of a check on the men after they enter the main gate, those disposed to shirk will take advantage of the opportunity to waste time in getting to their places after they have recorded their entrance. To prevent these losses the large

firms have been forced to adopt some plan which would record the employee's entrance into the department in which he is due. A check plan of surmounting the difficulty is to have a clerk distribute the checks at some main entrance, and then require each man to hang his check upon a board within the department in which he is working. This scheme proves effective in insuring the prompt appearance of the men in their departments, but it involves more clerical work than is necessary, because it requires a set of clerks at the entrance gates as well as another set who make record of the checks as they are hung in the departments. In order to reduce clerical work to a minimum and at the same time record the time accurately, mechanical devices have been perfected.

5. The recording clock. The greatest improvement that has been made in timekeeping devices is the introduction of the recording time-clock. There are a number of styles and varieties on the market, but all aim to:

1. Enable the employee to record his own time of entering and leaving the plant, thus preventing errors on the part of timekeepers.

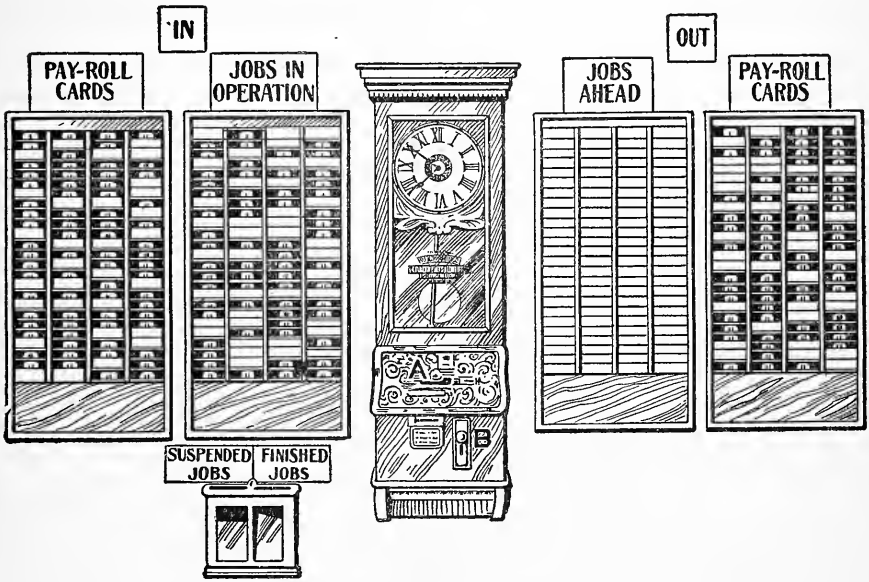
2. Enable the timekeeper to compute readily the number of hours each employee has to his credit, thus saving clerical work in making up the pay-rolls.

3. Prevent employees from entering the departments after starting time and leaving before quitting time.

These clocks are often used in connection with a shop cost system, and have proven very satisfactory. (See Fig. 28.)

According to this scheme a card is made out once every week or two weeks for each man. The man gets a numbered card, which is placed in the rack "out" before he enters the plant. When he goes to his department he inserts the card into the slot A, depresses the knob B, which records his time of entering. The card is then placed on the "in" rack. When he leaves the plant he takes the card from the

"in" rack, goes through a similar process, and records his leaving time, after which he places it in the "out" rack. This card at the end of the week, two weeks, or half month, records the total number of hours he was within the plant, and all latenesses or irregular leaving are stamped in red ink, thus calling attention at once to his delinquencies. At



By courtesy of International Time Recording Co., Endicott, N. Y.

FIG. 28.—Recording Clock with Cost Equipment. Each clock can conveniently keep record of two hundred people.

the end of every day, the timekeeper enters the daily hours in the total column, so that at the end of the period the cards can readily be made up and each man given his wages from the record. In many cases the back of the card is used as a check, so that the payment is made by merely having the paymaster and foreman sign and countersign the back of it. In any case, the cards for each man are kept and filed under his name, thus giving a truthful record of his regularity as a worker, truthful because it shows him by his own actions and not by a report of opinions.

The recording clocks help in making out the pay-rolls, and in keeping accurate record of the men passing in and out of the plant; but if the time scheme does only this, the firm has a very poor system. Good accounting demands that no plan is complete unless it can be verified automatically from independent sources. Moreover, one should know not only that a man has been present during a certain period, but also that he was an efficient worker while he was present. His efficiency can be determined by knowing what he has done with the time recorded on his time card.

Several schemes may be cited by which a record is kept of a man's actions while within the plant.

1. Send a timekeeper around every day to get from the workmen the time they expend on each job or contract.

2. Have the man list on a card his tasks from the beginning to the end of the day.

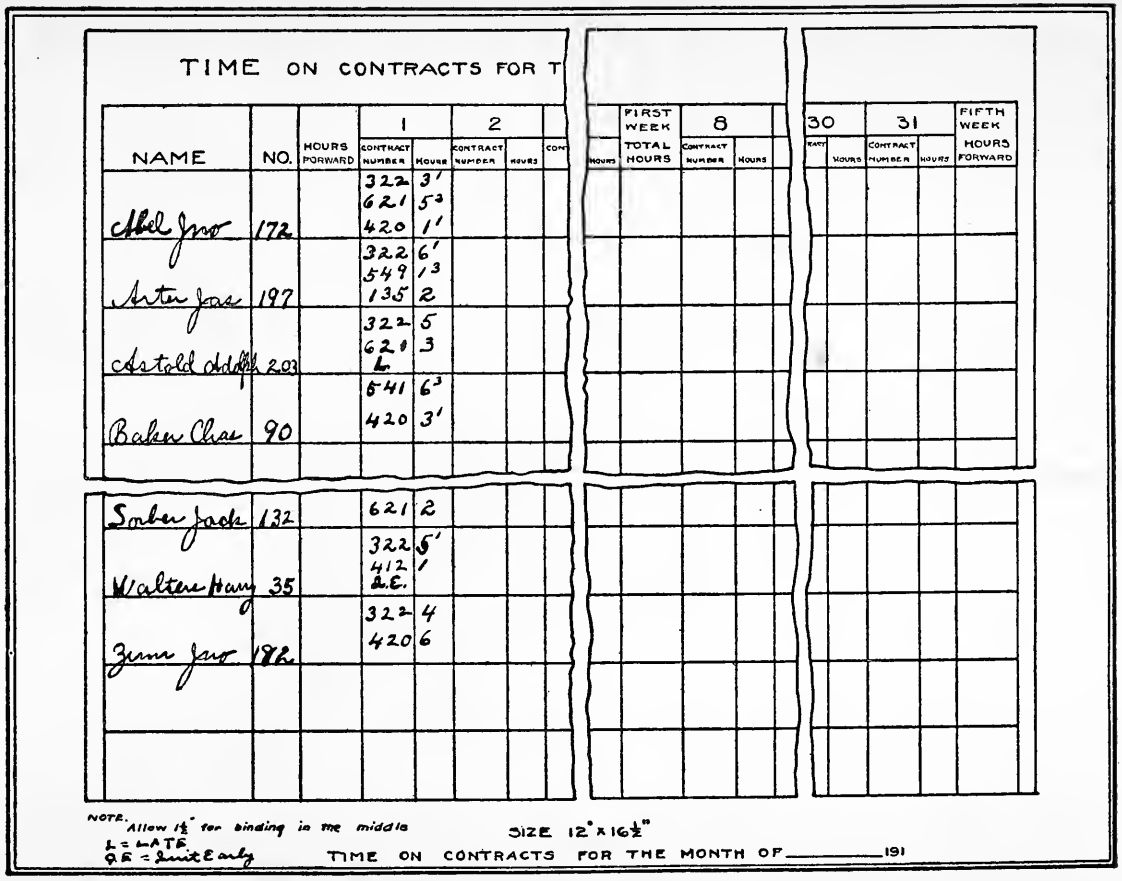
3. Have the man record on separate slips of paper for each contract the hours he spent on each particular job.

4. Have the office attach to each job, or piece of material, a tag on which the workman records his name or number and the time for his operation.

5. Have a multiple part tag attached by the office, so made that as each operation is completed, the workman tears off a portion on which is stated his operation, number, and time elapsed.

6. Have the office make out a slip for each operation to be performed on every piece of work for every contract. In this case the man is allotted the work, and the time is stamped when he is given the paper. When he returns it, it is again stamped, and the elapsed hours and minutes will show his time on the job. Another slip is immediately given him, so that he has mapped out for him his entire work.

In the first scheme, the timekeeper is sent around to enter in a book the time each man spends on each contract. (See Fig. 29.) The time allotted to each contract may be quite



TIME ON CONTRACTS FOR T

NAME	NO.	HOURS FORWARD	1 CONTRACT NUMBER	1 HOURS	2 CONTRACT NUMBER	2 HOURS	CON	HOURS	FIRST WEEK TOTAL HOURS	8 CONTRACT NUMBER	8 HOURS	30	31 CONTRACT NUMBER	31 HOURS	FIFTH WEEK HOURS FORWARD
Abel Jno	172		322	3'											
			621	5 3											
			420	1'											
Arter Jas	197		322	6'											
			549	1 3											
			135	2											
Astold Adolph	203		322	5											
			621 L	3											
Baker Chas	90		541	6 3											
			420	3'											
Sober Jack	132		621	2											
			322	5'											
			412	1											
Walter Harry	35		2.E.												
			322	4											
Zinn Jno	182		420	6											

NOTE. Allow 1½" for binding in the middle

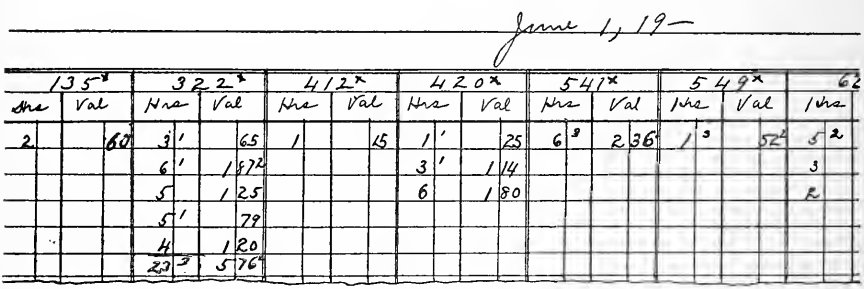
L = LATE
QE = Quite Early

SIZE 12" x 16½"

TIME ON CONTRACTS FOR THE MONTH OF _____ 191

FIG. 29.—Workmen's Monthly Time Book.

inaccurate, especially if the shop has several contracts or different classes of orders. In one plant where this scheme was in operation, the men would give the wildest kind of guesses as to the time they spent on each job. Their only care was to see that the amounts they apportioned around equalled the total time they spent within the plant. Coupled with its inaccuracy, such a plan entails an unnecessary amount of clerical labor; because the time of each contract must be summarized on an analysis sheet (see Fig. 30) be-



x Contract numbers.

FIG. 30.—Daily Analysis Sheet showing Method of Distributing Time.

fore it can be finally allotted to the individual contracts. (See Fig. 32.) This labor has been reduced to a very great extent, however, by having the time-book ruled in columns for each contract, and by inserting in their respective columns the time that the workmen expended. The footings of these columns equal the time expended on the different contracts by the end of the week. However, in places where the shop has a great many contracts the time-book increases to such large proportions, and the ruling becomes so elaborate that the columnar books become cumbersome and expensive.

The second scheme of having the men list their tasks on a card (see Fig. 31) was introduced for the purpose of making the men more careful in apportioning their time, the assumption being that if they could record their time as they

completed each job they would find it just as easy to be accurate as to be inaccurate in distributing their labor by contracts. The scheme is weak in that it is almost impossible to make men record their hours as they complete their tasks. In about eight cases out of ten the men have their pencils and cards securely locked in their tool boxes during the time they are working. Toward the end of the day they make out

DAILY TIME DISTRIBUTION TICKET

June 1 191

WORKMAN NO. 172 NAME Abel, John

CONTRACT NO	OPERATION	HOURS	RATE	VALUE
322	Fitting	3'	.20	.65
621	"	6"		1.10
420	"	1'		.25
		10		
				2.00

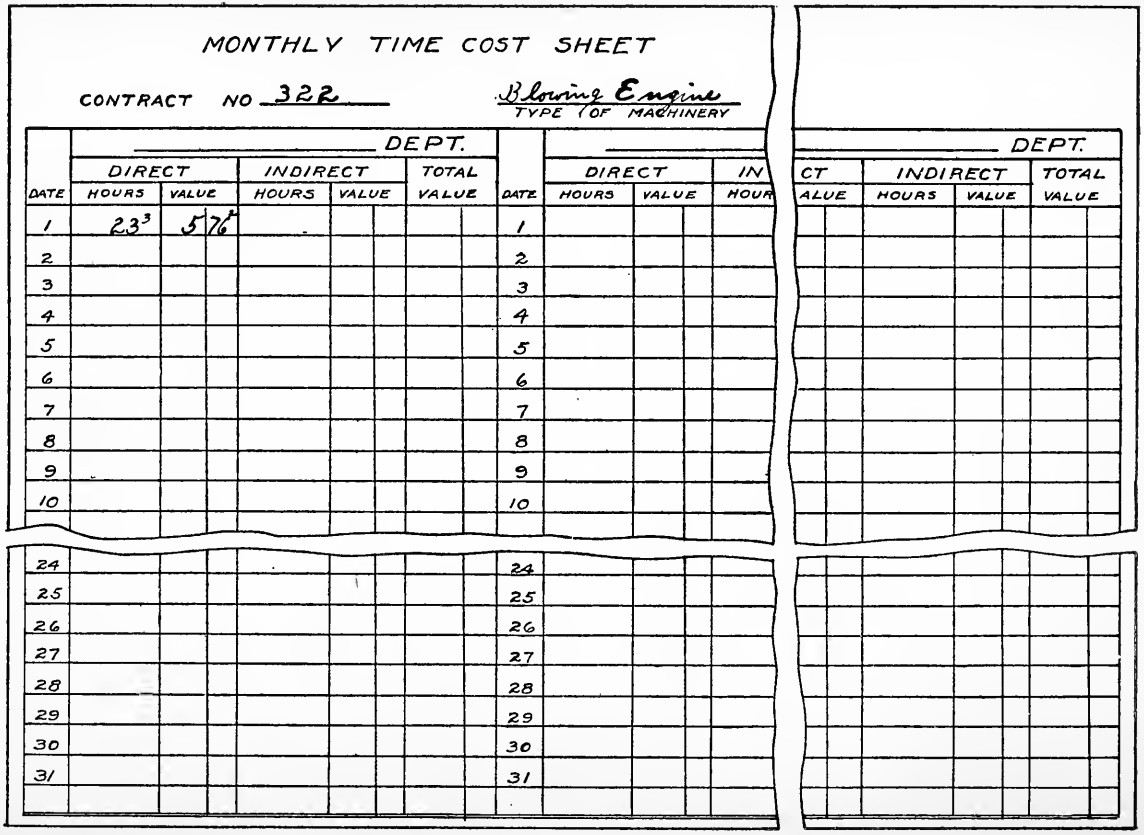
TOTAL $2.00 Wilson GANG BOSS

Size 3″ x 5″.

FIG. 31.

their time, apportioning the hours very largely according to their fancy. The result of this scheme is that it is no more accurate than the first, nor does it save clerical labor, because the cards must be sorted by contracts and then totaled on separate contract sheets (see Fig. 32) before they can be recapitulated. In one respect, the card system does save time. It dispenses with the services of the timekeeper, who goes around quizzing the men.

In the third scheme, the man makes out a separate slip of paper for each contract on which he works. (See Fig. 33.) Here the time is not apportioned any more accurately to the



MONTHLY TIME COST SHEET

CONTRACT NO 322 — Blowing Engine (TYPE OF MACHINERY)

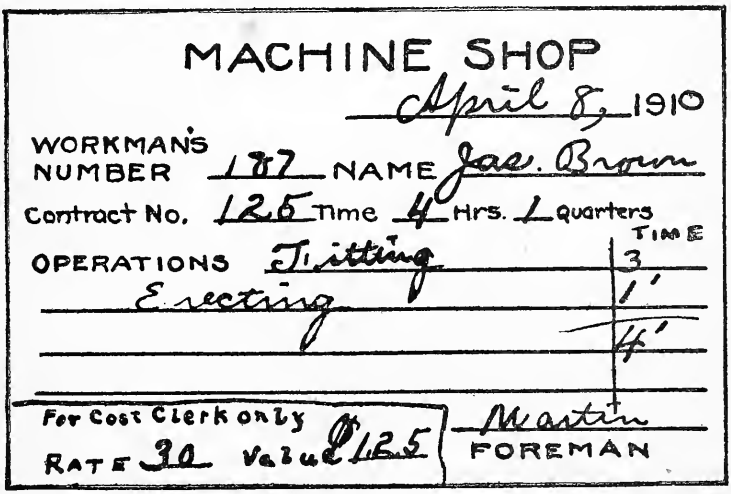
DEPT.						DEPT.					
	DIRECT		INDIRECT		TOTAL		DIRECT		IN	CT	INDIRECT		TOTAL
DATE	HOURS	VALUE	HOURS	VALUE	VALUE	DATE	HOURS	VALUE	HOUR	ALUE	HOURS	VALUE	VALUE
1	23[3]	5 76[4]				1							
2						2							
3						3							
4						4							
5						5							
6						6							
7						7							
8						8							
9						9							
10						10							
24						24							
25						25							
26						26							
27						27							
28						28							
29						29							
30						30							
31						31							

NOTE
Allow 1½" for binding in the middle

SIZE 9½" x 24"

FIG. 32.

contracts. The men, as a rule, do not make any more effort to be exact in their statements because of these contract slips. The pads of slips, like the cards, are either locked in the tool boxes or are in the hands of gang bosses, who give them to the men at the end of the day. The separate slip system, however, has the advantage of saving the clerks the trouble of resorting the papers to charge properly the time to the contracts. With this scheme, the total time for each



Size 3″ x 5″.

FIG. 33.—Individual Contract Time Slip.

contract each day can be obtained at once by one sorting, and then by listing on the adding machine the time cost of the various operations.

The fourth method. There are two ways in which the tag can be used, viz., not as a production order, or as a production order. According to the first scheme, as the workman gives the piece to the next person in line he puts on the tag (Fig. 34) his number and the number of hours he worked, stating the operations which he performed. This scheme tends to make the man more accurate in his statements because the tag is always with the job, and must be filled out

before being handed to the next worker. It saves labor for the clerks in analyzing the time by contracts, because each tag stands for one contract only, and the total time on the tag represents the total direct labor cost of the contract up to the last operation performed. The scheme does not, however,

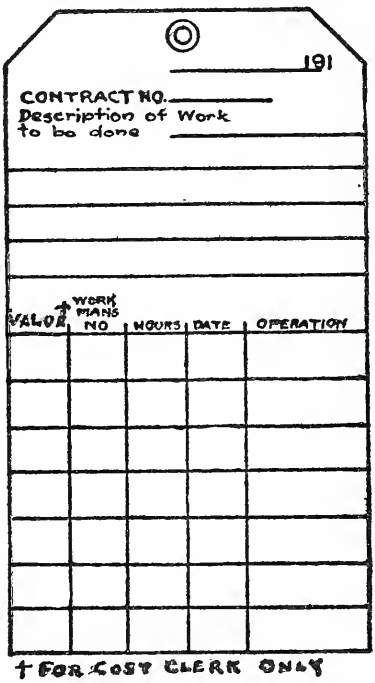


FIG. 34.—This tag is not detachable. It shows the length of time and wage cost of each operation. By sorting these tags by workman's number one can check the correctness of the recording clock or time book.

necessarily make the men more accurate, if they desire to deceive; because with a number of contracts on their hands at the same time, some being worked upon and some awaiting their efforts, the men, especially if they are working under a premium plan or any kind of piece-rate scheme, will be tempted to allot time in such a way that the contracts do

not really get charged with their proper shares of time. For instance, in one place men were paid a certain price for reaming out holes on a certain class of work. They were paid another price for reaming under other conditions. It happened that the time allotted for the first job was so very generous that in spite of the fact that the second one was actually unfair, the men never complained because both kinds of holes invariably went together, and instead of stating the exact time it took to do each class of holes they understated their actual time where they had the meager allowance, and overstated it where they had the generous one. In the long run they obtained unusually high wages, and the cost was exceedingly unfairly distributed on the work.

The multiple part tag used as a production order is arranged as in Fig. 35. Every piece of work must go through a certain number of steps or processes. If the work is standardized, regularly printed tags may be attached to each piece of material, as, for example, in a stocking factory. If the shop manufactures things which vary, the multiple part tag may be printed in blank and the steps filled in on the blank as they are performed. When a man performs his part of the task, he merely tears off the step which he performed, and then affixes his number with the hours worked. In this way the time department receives a record by contract, and likewise by men by first arranging all the slips by contracts, and summarizing them on the contract sheet (see Fig. 32), and then rearranging them by men and carrying the wages to each man's personal account. This form of tag is very good for continuous process industries or for work of a machine order. When, however, it is a question of the erecting of engines where several people work on the job at once, and where it takes some time to finish the job, the tags do not fill all the requirements, because it is difficult to enter more than one man's number on a space. For work of such a character a good scheme is to put the task under the immediate control

of a gang boss who will be held responsible for carrying out the details. It is well in connection with this plan to use Scheme No. 6, wherein the workman secures from the time clerk a slip of paper indicating the task his gang boss gave him and the time when he began it. As soon as he completes

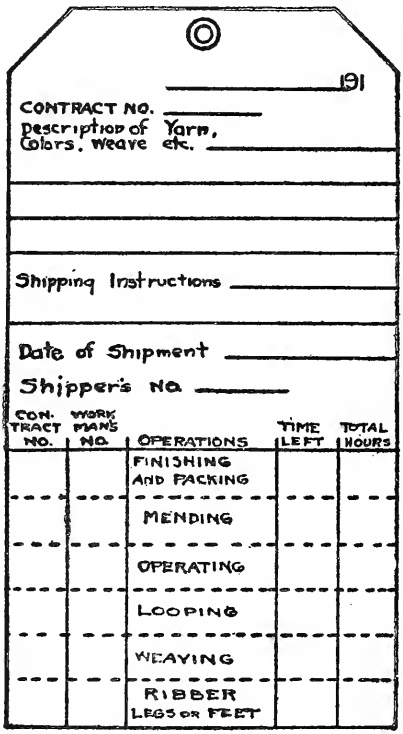


FIG. 35.—Tag detachable along dotted lines. It serves as a production order, besides showing time of each operation.

the task he should be required to return the paper to the clerk, who will stamp the time returned, and the elapsed period of duration will show the length of time it took to perform the work. (See Fig. 36.)

In this way, the gang boss need not keep the time nor be held responsible for its keeping. The workman cannot apportion the hours as he fancies, because he can start no task

without his order slip, on which must be stamped, as he gets it, the time he received it.

In order to use any of these devices to determine the efficiency of the men it is necessary to make a record of the men. Two schemes may be used. If the work is paid on the piece basis, one of the best records of a man's efficiency is the amount of wages he draws. This record can be kept in a wage-record book (Fig. 37), where the names of all the men in each class are grouped, or an output record may be

MACHINE SHOP

_____ 191

Workman's No. _____ Contract No. _____

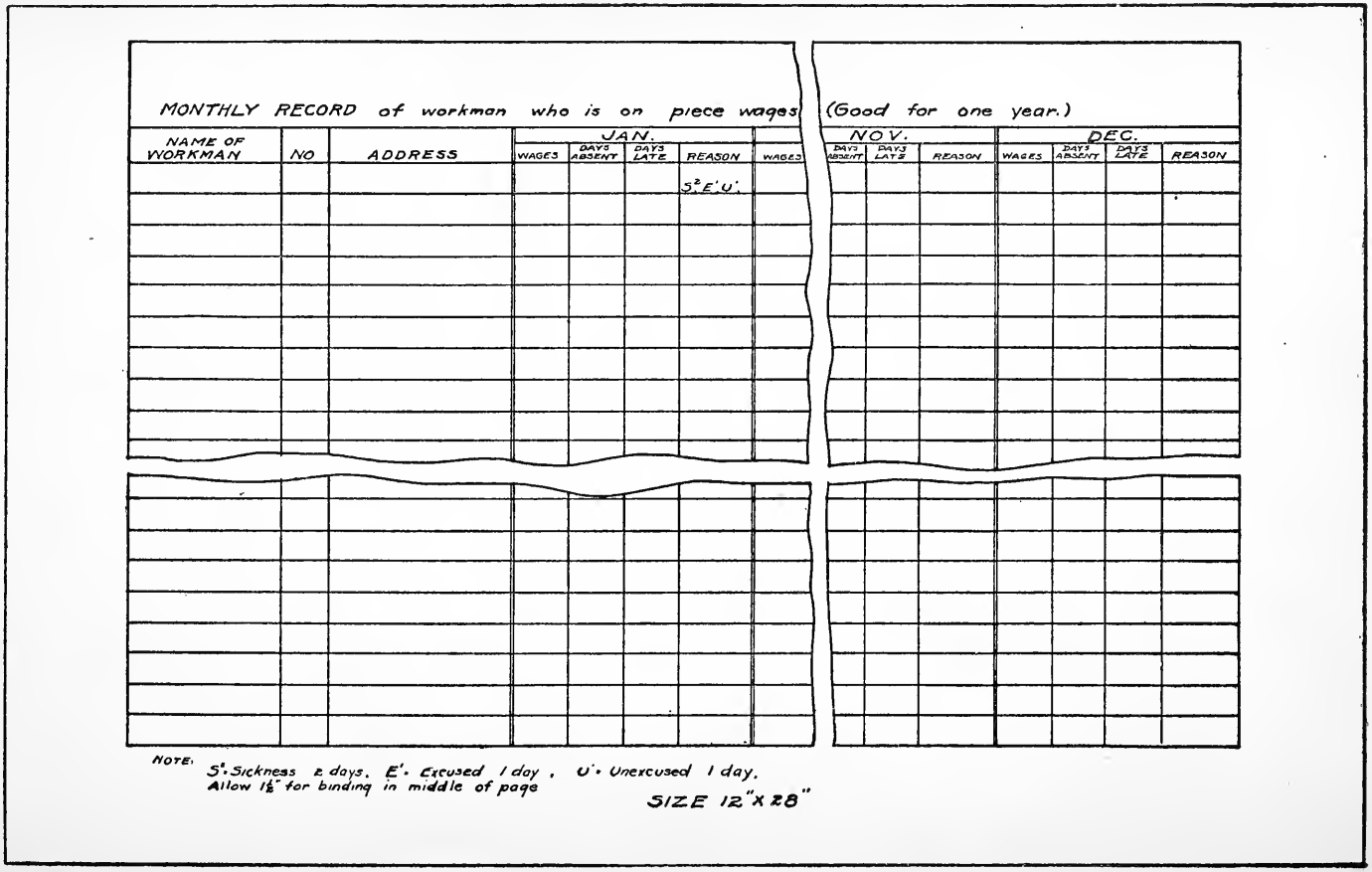
OPERATION _____

Time Started	Time Returned	Elapsed Time
		For Cost Clerk Only Rate _____ Direct Labor _____ Total _____

FIG. 36.—Individual Operation Time Slip for each Contract.

made on a separate monthly memorandum output card. (See Fig. 38.)

If, however, the man is paid on the day plan, it is necessary to standardize the tasks and compare workmen who do similar classes of work. If it is hard to standardize the tasks, as it is in the erecting of large machines, the gang bosses in charge of the erection may be charged with their labor costs (see Fig. 32), and comparative records made with other men who have worked, or are working, on similar con-


MONTHLY RECORD of workman who is on piece wages (Good for one year.)

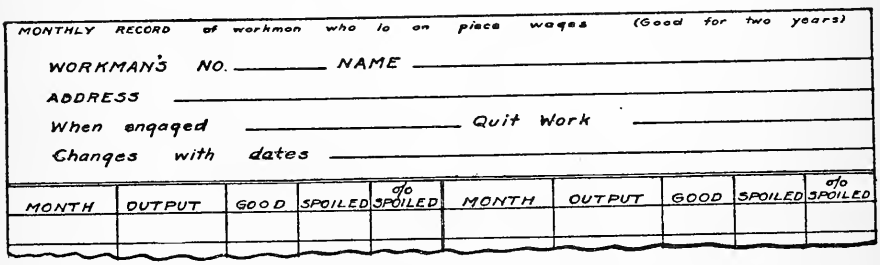
NAME OF WORKMAN	NO	ADDRESS	JAN. WAGES	JAN. DAYS ABSENT	JAN. DAYS LATE	JAN. REASON	NOV. WAGES	NOV. DAYS ABSENT	NOV. DAYS LATE	NOV. REASON	DEC. WAGES	DEC. DAYS ABSENT	DEC. DAYS LATE	DEC. REASON
						S²E'U'								

NOTE. S'. Sickness 2 days. E'. Excused 1 day. U'. Unexcused 1 day.
Allow 1½" for binding in middle of page

SIZE 12"X 28"

FIG. 37.

tracts. The gang boss can be held responsible for too high a cost; and if an exact and definite record is kept, he can at once be notified when his costs are running high, and be asked to give the reasons for it. If there is any complaint to make against any particular men, the foreman can shift the men reported delinquent to other gang bosses; and if through several trials the labor costs increase with these workmen, proper means can then be taken to improve the labor force. This method of comparison, sometimes termed the deadly parallel, does away with elaborate records and obviates the necessity of marking systems for the individual


MONTHLY RECORD of workmen who lo on piece wages (Good for two years)

WORKMAN'S NO. _____ NAME _____

ADDRESS _____

When engaged _____ Quit Work _____

Changes with dates _____

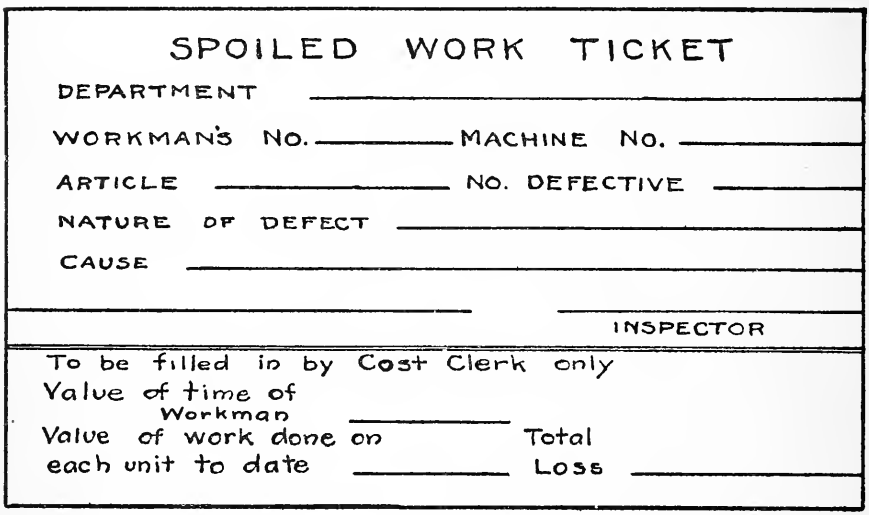
MONTH	OUTPUT	GOOD	SPOILED	% SPOILED	MONTH	OUTPUT	GOOD	SPOILED	% SPOILED

FIG. 38.—Monthly Memorandum Card showing Efficiency of Piece Worker.

men. Some firms adopt a system of grades and marks based upon an estimate more or less accurate of what each man does, and the number of mistakes he makes. While this scheme may have some advantages, it is, for industrial enterprises, cumbersome and expensive to keep up, and it is really less satisfactory than the report system above outlined. Of course, in connection with the scheme suggested, there is an individual card kept for the workman or foreman; and if he is responsible for any destruction of material or breakage of tools it is recorded against him. (See Fig. 38.)

A good way to know accurately of a man's spoiled work and mistakes is to have a spoiled work slip made out for his work as it is spoiled. (See Fig. 39.) This should be signed by the workman and the inspector with the reasons for the

rejection and the slip filed as an original record. At the end of the month the slips can be summarized, and a record made on his individual report card. (See Fig. 38.) These individual cards soon indicate to the foremen the inefficient subordinates, who should gradually be weeded out of their departments, and deserving ones promoted as opportunity occurs. Every time a change is made in relation to any


SPOILED WORK TICKET

DEPARTMENT _____

WORKMAN'S NO. _____ MACHINE NO. _____

ARTICLE _____ NO. DEFECTIVE _____

NATURE OF DEFECT _____

CAUSE _____

_____ _____

INSPECTOR

To be filled in by Cost Clerk only

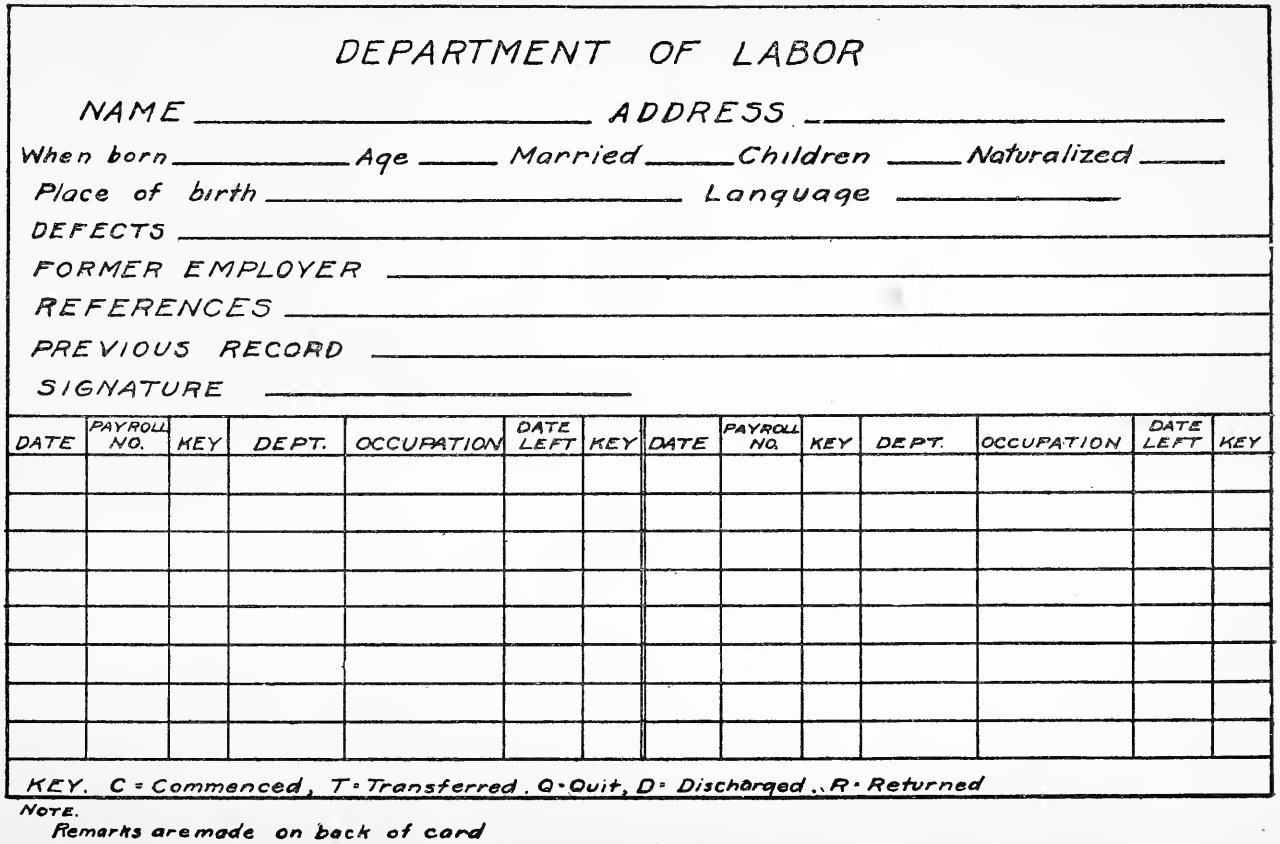
Value of time of Workman _____

Value of work done on each unit to date _____ Total Loss _____

SIZE 3"x5"

FIG. 39.

man's position, it should be entered on his permanent file card. (See Fig. 40.) At the end of each year the general average of the man, as shown by his output record (Fig. 38), should be entered on the back of his Permanent Record Card filed in the Employment Bureau's office. (See Fig. 40.) This last card should not be destroyed, unless the employee is known to be dead. While he is retained in the plant, it should be filed in one drawer, and when he is released it should be taken out of the employed file and entered in the unemployed file, so that whenever a man seeks reemployment he can be at once investigated. Some firms obviate the ne-



DEPARTMENT OF LABOR

NAME _____ ADDRESS _____

When born _____ Age _____ Married _____ Children _____ Naturalized _____

Place of birth _____ Language _____

DEFECTS _____

FORMER EMPLOYER _____

REFERENCES _____

PREVIOUS RECORD _____

SIGNATURE _____

DATE	PAYROLL NO.	KEY	DEPT.	OCCUPATION	DATE LEFT	KEY	DATE	PAYROLL NO.	KEY	DEPT.	OCCUPATION	DATE LEFT	KEY

KEY. C = Commenced, T = Transferred, Q = Quit, D = Discharged, R = Returned

NOTE.
Remarks are made on back of card

SIZE 5" x 8"

FIG. 40.—Permanent Record Card of Employees.

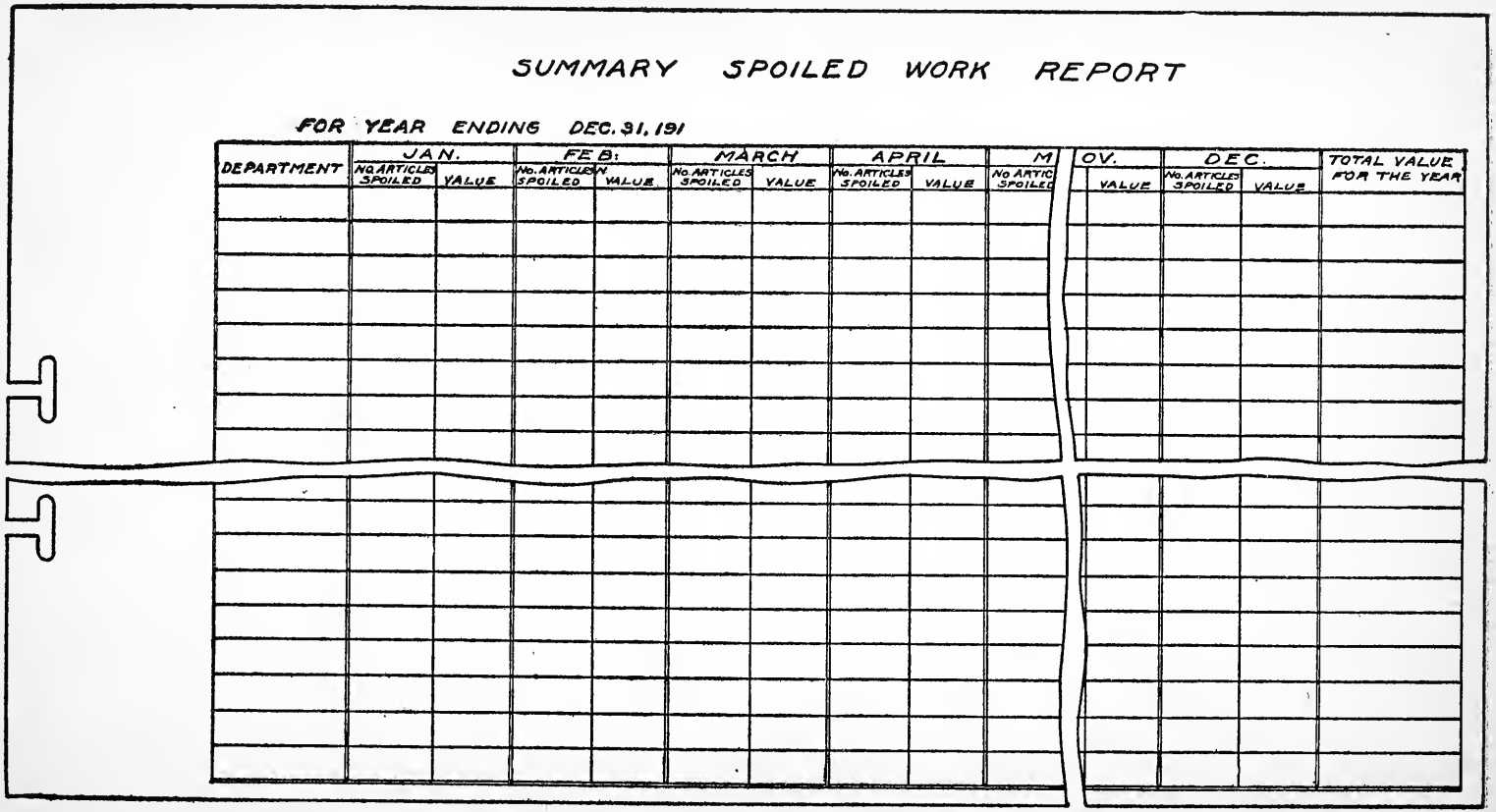


FIG. 41.—Report summarizing Spoiled Work of Entire Plant by Departments.

cessity of copying the workman's record twice by combining the essential features of the two cards shown in Figs. 38 and 40, and filing them in the foreman's or manager's office while the men are engaged; and in event of discharge or quitting they are sent to the employment office. In this way the employment office has on file only the former employees, while the managers keep in touch with the present help. This method of handling cards has its advantages and dis-

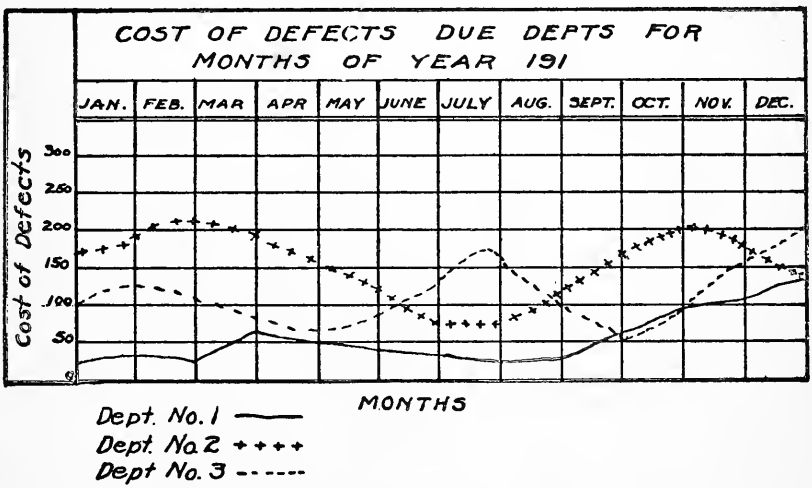
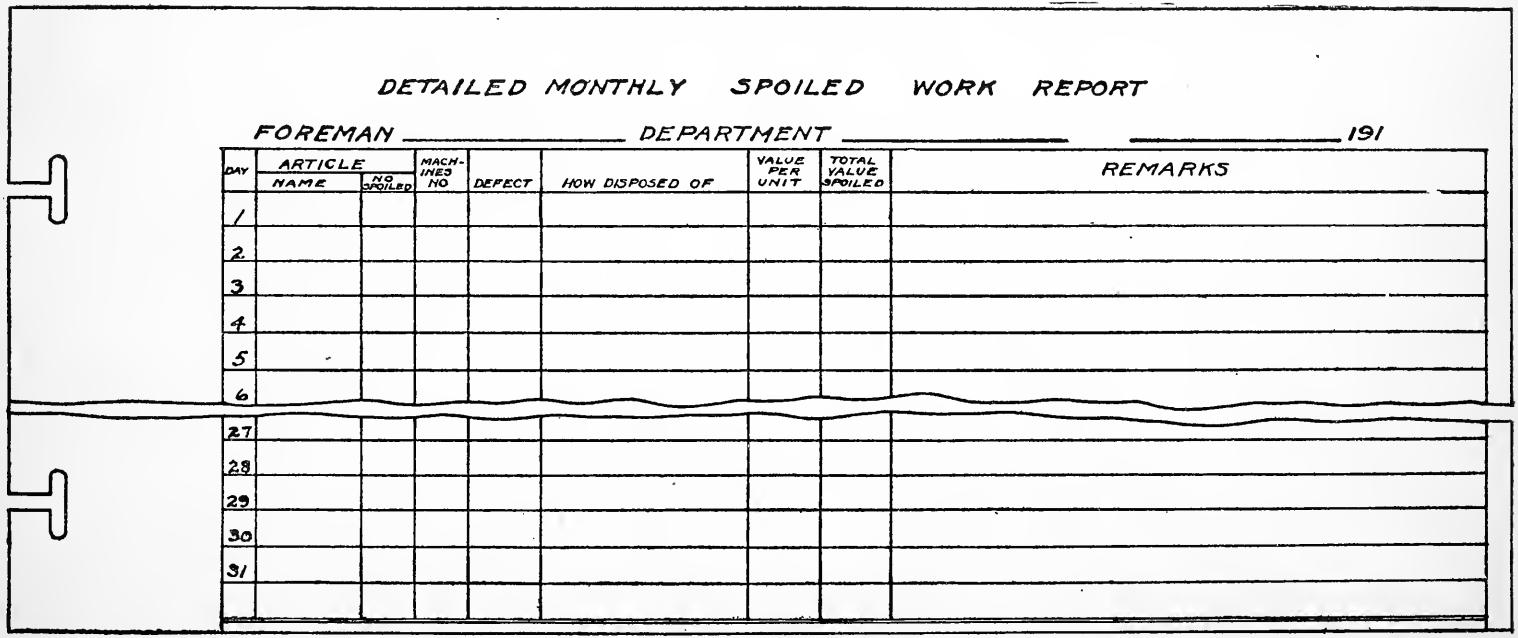


FIG. 42.—Chart of Errors showing Monthly Efficiencies of Departments.

advantages. It is cheaper in cards, filing space, and copying, but the cards are apt to become soiled, torn, mislaid, and even permanently lost in the general handling and passage between departments. If the employment office retains its copy at all times, then the loss of the output card in the shop is not so serious as it is when only one card is kept.

While the manager should have a record of the efficiency of each man in the plant, that is not sufficient. He should know just how much each department wastes and loses, and what have been the causes for all losses. A foreman's efficiency is determined by his ability to prevent men from wasting time and spoiling material.



DETAILED MONTHLY SPOILED WORK REPORT

FOREMAN _____ DEPARTMENT _____ _____ 191

DAY	ARTICLE NAME	ARTICLE NO SPOILED	MACHINES NO	DEFECT	HOW DISPOSED OF	VALUE PER UNIT	TOTAL VALUE SPOILED	REMARKS
1								
2								
3								
4								
5								
6								
27								
28								
29								
30								
31								

FIG. 43.—Detailed Monthly Spoiled Work Report for each Department.

Two plans of recording defects can be used, either summarize the errors in tables (see Fig. 41), or make a chart of the defects chargeable to each department according to their number or cost, or both number and cost. (See Fig. 42.) To make the charts involves but slightly added expense above the cost of tabulation, because the information must be tabulated before it can be charted. The added advantage, however, is worth more than the increased cost; because a chart shows, at a glance, tendencies over periods of months, while the table compares for only one month at a time.

If a manager keeps these general comparative records, and if, in addition, he has a detailed record of why the losses occurred in each department (see Fig. 43), he can intelligently criticise the work of his lieutenants and can make changes which will be improvements and not mere "shake-ups."

CHAPTER XVII

RECORD OF RAW MATERIALS

In the process of manufacturing goods, two classes of material are used, direct and indirect materials. The direct are those which go into the manufacturing of a product, and stay with it when it is in its marketable form. The indirect are goods used in the process of manufacturing, but which never become a part of the product. In making a desk, for instance, lumber, nails, varnish, rotten stone, sand paper, polishing cloth, and other materials are used. The lumber, nails, and locks are part of the desk when finished; while the rotten stone, sand paper, and polishing cloths though necessary in order to put a beautiful finish on the desk, do not appear as part of it when ready for the consumer.

In making an engine it is necessary to use iron, steel, brass, and other metals, and also molds, oils, waste, and other materials which are quite as necessary as are the steel, iron, and brass, although they appear nowhere in the make-up of the engine.

Good management insists upon two things regarding raw materials:

1. The greatest care possible should be exercised in preventing waste and losses on direct material.

2. The greatest possible economy to prevent undue expenditures for the indirect materials.

To secure maximum economy in materials it is necessary to:

1. Purchase them from the lowest-priced firms when goods are at their lowest prices.

2. See that the material comes up to the contracted standard of excellence in quality.

3. See that the quantity purchased is obtained.

4. See that the goods are delivered at the specified time.

5. See that they are properly housed and stored.

6. See that there is no unnecessary waste in the plant.

7. See that no losses can occur, except through waste.

In order to accomplish these seven ends it is necessary to have a complete record of the most reasonable supply firms, to know the best time to purchase goods, and to have an exact checking system.

1. To attain the first aim, the purchasing department should be in constant touch with the market from which the raw materials are obtained. In small concerns, some member should gather information as to the causes that influence the prices of raw materials. He should find out the seasons when they are cheapest, should know the prices of the various usable qualities, and keep himself informed as to weather conditions, crop failures, and other causes likely to affect prices. The firm should also take advantage of the market, e.g., if a cotton manufacturer finds that he can purchase his cotton most advantageously during a certain month in the year, he should arrange his finances so that he can acquire his cotton at that time, but he should probably not purchase an entire year's stock of raw material during a single month or so, and then pay storage on his purchased goods and interest on the money used to secure them.

Most companies have a regular purchasing agent or purchasing department to look after securing supplies. In some concerns, a very strict account is kept of the price quotations for every day in the year; and in some cases, the price changes are charted on squared paper, and curves are plotted showing price movements for each day of the year. For most lines of material, and for all ordinary businesses, such a scheme is unnecessary. Some goods have higher prices

during some seasons than others, and the management of the plant should endeavor to buy during the favorable time, although if he must borrow funds, the price he pays for his goods will be the market price plus interest, as well as storage and insurance.

2. Quite as important as purchasing the material at the right time and at the lowest possible price is to have some scheme by which one can be certain of purchasing the most useful quality of material. The common plan is for the purchasing department to establish standards for all of the materials to be purchased, and then have all goods tested before acceptance. Many large concerns have well-equipped laboratories that establish standards and test all purchased materials in order to see that they fulfil the terms of the specifications. In many branches of work it is not only desirable to make a preliminary test of the material, but also to keep track of the material while it is going through the plant, and to test the finished product of which it becomes a part. This is especially important for plants having no special department for testing materials and such goods as are hard to standardize.

It is not difficult to keep track of materials. A continuous industry plant, which manufactures several styles and grades of some textile material, can keep record of the raw material which goes into the various lots of goods by numbering the lots and recording specifically the material charged to these lots. Whoever buys the finished product will have the lot number recorded against his name. If the finished product from this raw material should turn out to be bad, or to be unsatisfactory to the customers either in wearing qualities or in other respects, they will report to the manufacturer who is able to tell, by turning to the Index Record (Fig. 44), which shows the customer's name and lot number, what raw goods proved to be unsatisfactory, and, as he keeps a record of his purchases, he is able to tell from

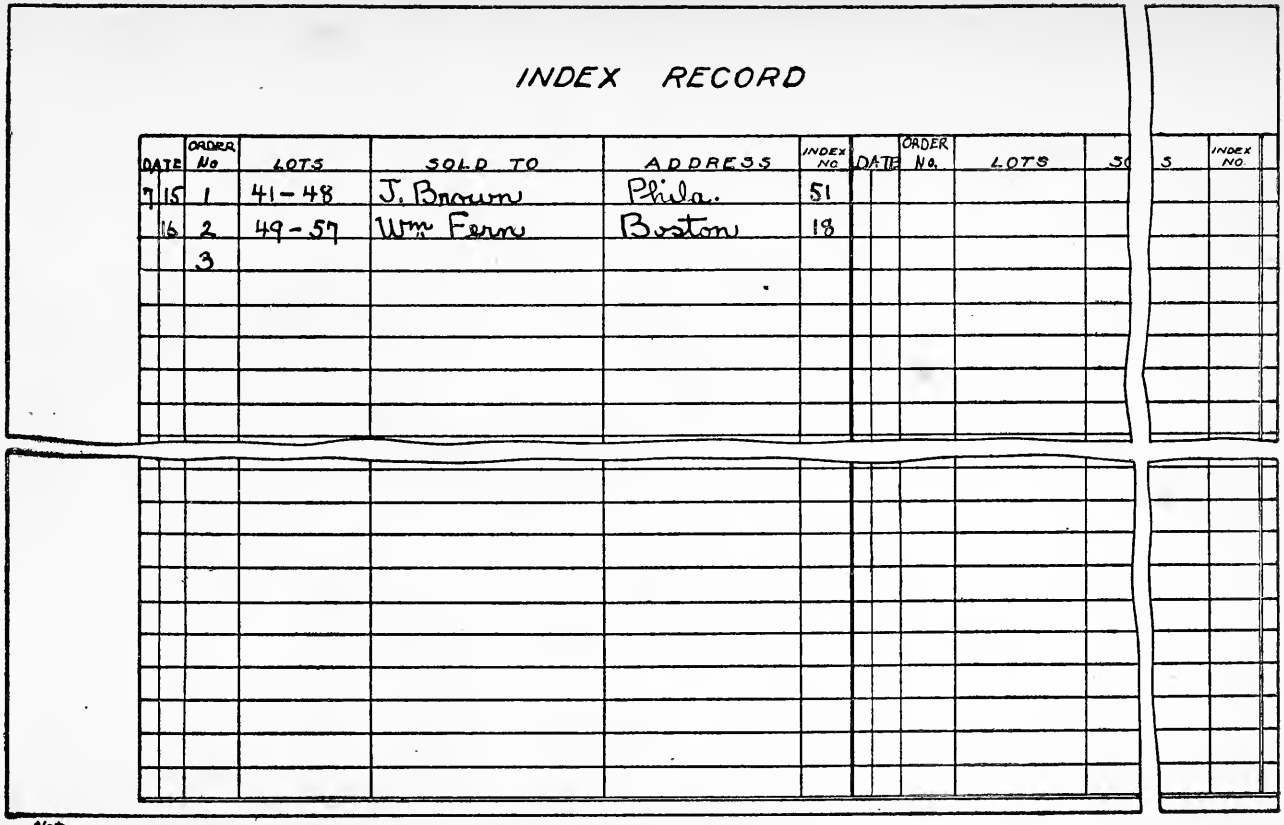
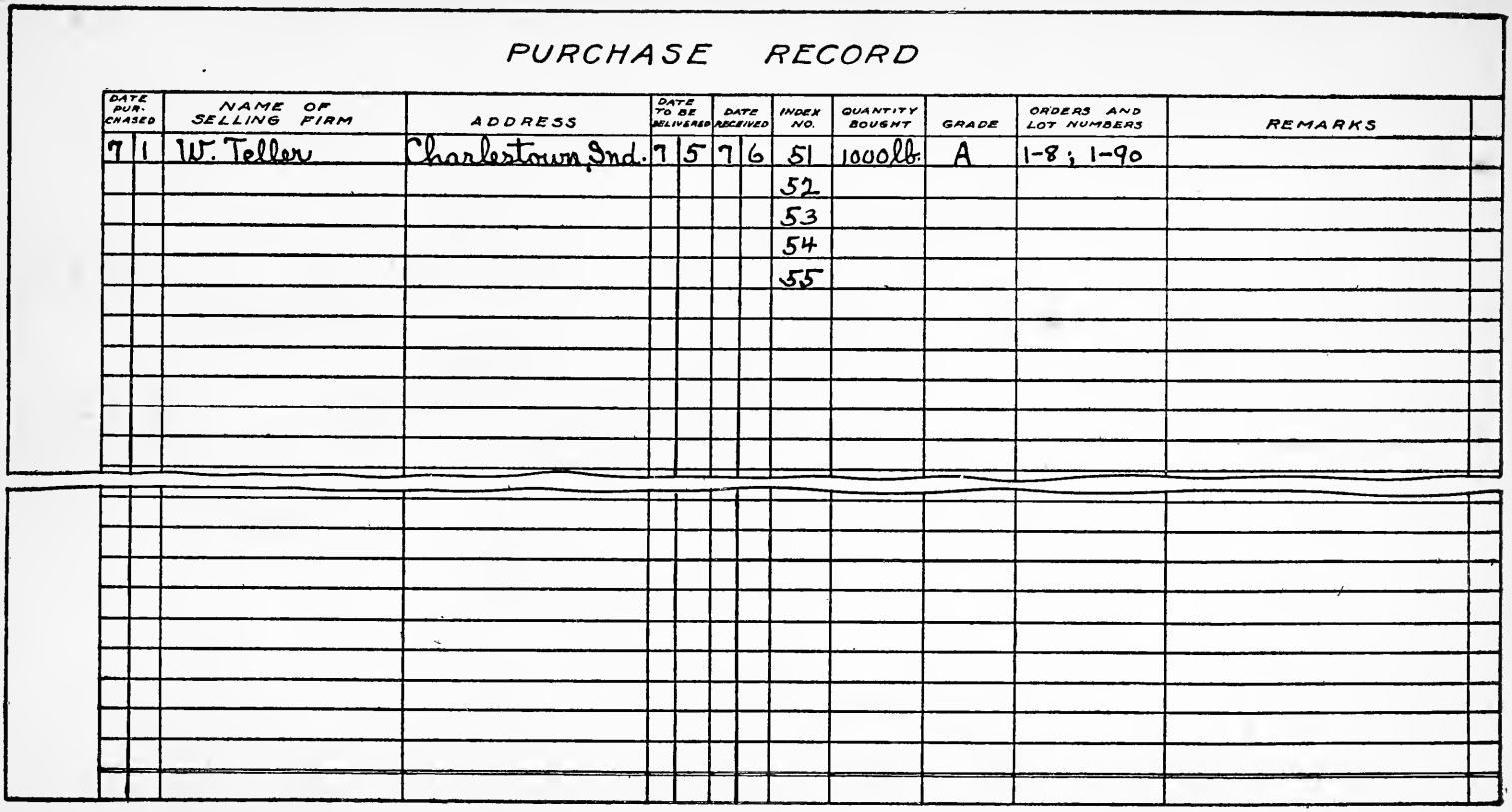


FIG. 44.—Index Record for keeping track of Customers and Wearing Qualities of Raw Materials.

whom he bought the unsatisfactory raw material. (See Fig. 45.)

To illustrate the records needed for an assembling industry an automobile plant may be selected. The parts of an automobile are purchased from widely different sources. If the product should prove unsatisfactory, the manager will hear specific complaints in the form of objections about some particular parts of the machine. If the defect is real, investigation will soon show whether it is due to faulty material or to workmanship, and if proper records are kept of the source of the former, it is not hard to discover where the fault lies. The fact that the material is bought from widely different sources does not offer any serious objection, because the firm, as a rule, buys the same parts from a very limited number of firms, e.g., the engines and engine parts will come from one or two firms, and their products have characteristics which soon betray their origin.

3. See that the quantity purchased is obtained. One of the most fruitful causes of losses in large concerns which do not have a good receiving system is shortness in weight or amount due either to mistakes or open dishonesty on the part of their employees and others. In order to see that the firm gets all the goods for which it pays, the usual plan is to establish a store-room and to let the order go through the following routine: Have the purchasing department make out the items in triplicate on a special blank, sending one copy to the firm from which they order, one to the receiving department, and retaining one on their own files. When the consignment arrives, the man in the store-room should be compelled to take his copy of the order, compare it with the invoice, and then check the actual items of the invoice against the goods received, sign the two slips, and send them up to the purchasing department, where they are checked against the purchasing department's copy, and approved. The invoice will be sent to the accounting department, which



PURCHASE RECORD

DATE PURCHASED	NAME OF SELLING FIRM	ADDRESS	DATE TO BE DELIVERED	DATE RECEIVED	INDEX NO.	QUANTITY BOUGHT	GRADE	ORDERS AND LOT NUMBERS	REMARKS
7 1	W. Teller	Charlestown, Ind.	7 5	7 6	51	1000lb.	A	1-8; 1-90	
					52				
					53				
					54				
					55				

FIG. 45.—Purchase Record used to determine Source of Defective Raw Material.

will select the paying day and credit the firm for the amount, while the other slip will be returned to the store-room, where it will be kept on file. The store-room records should be kept in the form of some kind of perpetual inventory.

A perpetual inventory is a record which shows at once the amount and value or the amount or value of goods on hand at any time. (See Fig. 46.) To have these perpetual inventories correct, there must be kept for each class of goods:

(a) A statement of all the goods received.

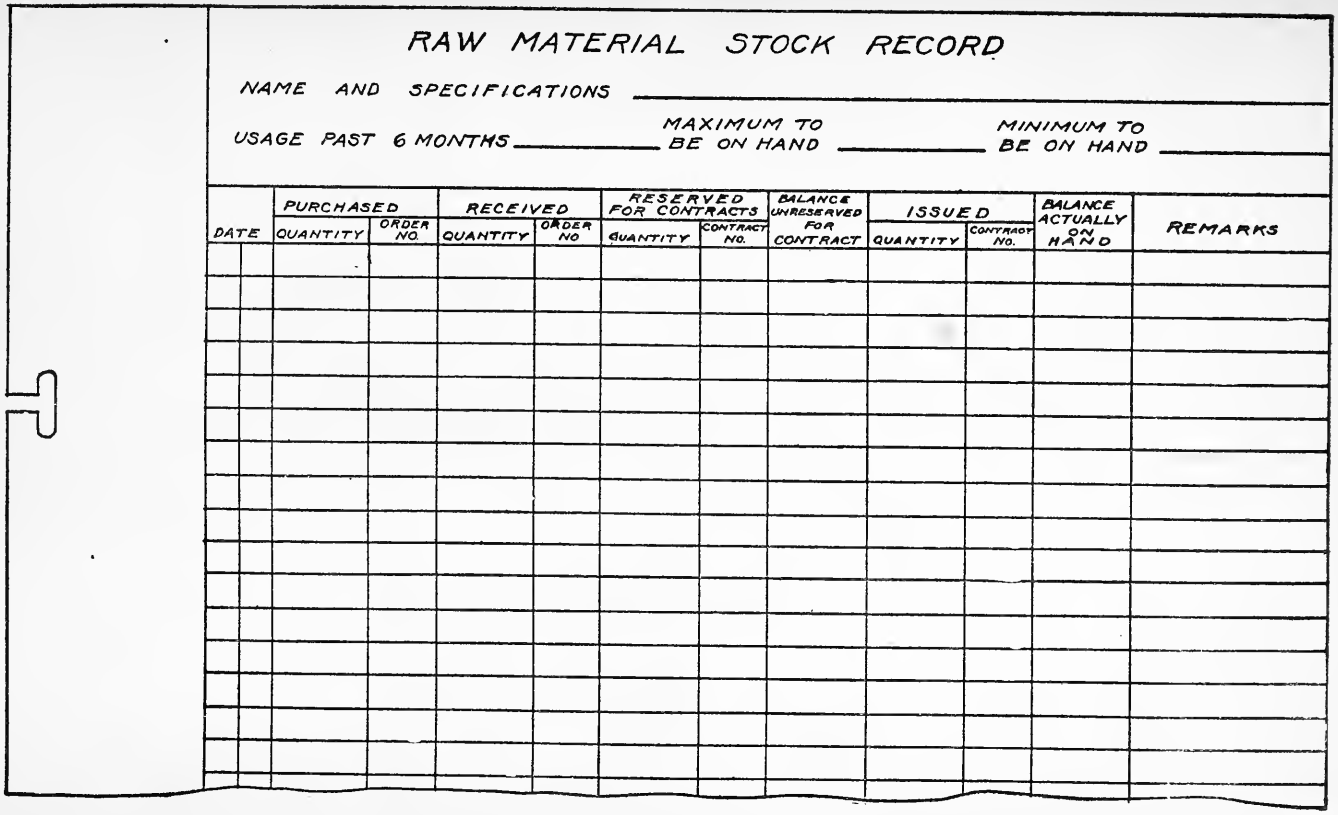
(b) A statement of all goods issued.

(c) A balance of goods on hand.

The accuracy of the book inventory is tested from time to time by an actual counting and valuing of the stock on hand, and a comparison of the results obtained by this means with the balances shown on the books.

There are two methods of keeping an inventory. One is, to have all the material arranged in bins and racks, and to have in front of every bin and rack a card or tag on which is placed the amounts of materials received, with dates and the amounts taken out with their dates. Two bins are often used to simplify the keeping track of the material, one bin being used to receive goods while they are being taken from the other. When the delivering bin is emptied, it is used to receive material, while the now emptied one becomes the receiving bin. The double bin idea is good, if there is sufficient space available in the stock-room, because it lessens the accumulation of shop-worn stock.

The record tag, however, is objectionable from two standpoints. In the first place, the tags are so widely distributed that it is inconvenient to see just how the stock stands, as shown by the records. It is inadvisable to remove the tags from the bins in order to ascertain the situation, because in the meantime someone may withdraw things; and, having no slip on which to enter withdrawals, fails to make any record, with a consequent inaccuracy in the records. It also



PERPETUAL INVENTORY STOCK RECORD

SIZE 15"X10"

FIG. 46.

frequently happens that the amounts are put down on the slips carelessly, and sometimes even by unauthorized persons. Of course, this latter difficulty could be overcome by not giving access to the store-rooms to anyone who has not proper authority, or who is not responsible for goods.

An inventory without these objections is a book ruled somewhat according to the form of Fig. 46. The book is put in charge of a storekeeper or a clerk, and no irresponsible person is permitted to take anything from the store-room. Everything received is entered in the book from the invoices, and everything given out must have a properly written requisition. Both the purchasing agent's authority checked against the invoices, and the requisitions are kept until the books are audited. The difference between these two shows the book balance, and should always be represented by the actual amount of goods on hand in the stock-room. The balance can be verified by inspection; and if, for any reason, there is a discrepancy, an investigation is in order.

4. While a firm may lose much on the value of the goods purchased if it does not have a well-planned receiving department, it may lose the profit of an entire contract if the raw material does not arrive in time for use when wanted. In order to get material delivered in time, the purchasing department should be notified long enough in advance to be able to anticipate all needs. With an inventory ledger of the type shown in Fig. 46, the storekeeper has little difficulty in keeping the purchasing department informed as to when it should go into the market for more goods. Whenever the storekeeper finds his balance to be below the minimum limit, he must at once report the approaching deficiency, thus giving the buyer ample time to replenish the stock. The purchasing agent should see that the minimum limit is set sufficiently high so that the store-room will never be completely out of anything that may be needed. The usual practice is

to have the storekeeper fill out a blank, telling the kind of stock needed and the maximum and minimum amounts carried. These reports are made out in duplicate, one for the information of the purchasing department, and one to be retained by the storekeeper for his own protection. The maximum point for the stock is fixed in order to prevent overbuying.

5. After adequate provision has been made for receiving goods and reporting deficiencies in deliveries and lowness in stock, there arises the problem of the care of the material. Losses in material may be from three sources:

(a) Bad storage, which causes actual deterioration in the goods.

(b) Storage which makes it possible for unauthorized people to have access to the store-room, and to steal or pilfer materials.

(c) Losses through waste.

If goods are properly stored, the first and second of these difficulties will be reduced to a minimum. If judgment is exercised in storing material, it will be found unnecessary to exercise the same precautions over all materials. It is unnecessary in a machine shop to store the rough castings with the same care that one should exercise in storing heavy machinery, and no one would exercise the same care in storing heavy machinery that he would exhibit in storing more valuable articles, like brass ware, oil cups, electric-light bulbs, and various other similar supplies. The latter stock should be kept strictly under control, and it should be impossible for one to get any of these things without proper authority, unless by actually breaking into some room or compartment.

While rough castings may very frequently be stored out in the open, it is inadvisable to do so unless absolutely necessary. There is an instance of a concern which had made several expensive castings of hollow wheel segments and arms, which it stored in the open in such a way that the hol-

low arms were turned upwards. In the course of a severe winter, which had many changes in temperature, the arms became filled with water which froze solid, and split them beyond all possibility of repair, entailing a complete loss to the company. Had the foreman in charge taken the precaution to cover the openings with boards, it would have prevented the water from getting in at all.

There are certain fabric goods, such as raw wool, cotton, and yarn, which must be kept from the weather, and yet which are of such a nature that there is no necessity for taking special precautions to prevent petty thieving. Workmen have little use for these things in small quantities, because they cannot sell small lots to advantage; and, it is hard for them to dispose of large amounts, because they usually have to establish relations with people who will dispose of such materials for them. Silk, however, must be very carefully watched because of its value.

The material on hand should be studied with reference to the liability of pilfering. The storage-rooms should be so arranged with shelving and racks that the material is at all times easily accessible for inventory, and is at the same time kept from contact with vermin, overheat, dampness, or anything that will hasten the deterioration of the goods.

Besides arranging the goods so as to be available, safe from the weather and secure from theft, the storekeepers should so arrange the material that it can be found by a comparative stranger. There are two methods of doing this. One is to arrange the materials according to some alphabetical plan, as for example putting all brass work, bolts, buckets, brooms, etc., in one section; the next section following with articles beginning with C, and so on. For a small shop, where the variety of goods is not large, this scheme is sufficient. If, however, the amount of stores is large, or the variety extensive, of which some are being called for constantly while others are not so much in demand, it is

wise economy for the storekeeper to put the former material close at hand, and the less used in the more remote places. When this scheme is adopted, the best plan is to number the bins in some well-recognized order, and to have an index book, which lists all the material according to name, size, and quality or other relations, and states, opposite the description, the number of the bin or section in which the listed material is to be found. Such a scheme saves much space in storing, and the goods are convenient to find and easy to handle.

6 and 7. After the goods have been properly stored, care must be taken to prevent loss of material by unnecessary waste and theft. Both ends can be accomplished by the same method, provided precautions are taken to keep everything under the absolute control of the storekeeper, and to hold him responsible for the proper issuance of goods.

A complete record of materials taken from a store-room may be kept in two ways. One is the voucher or requisition plan, by which the person receives the goods upon the presentation of a properly authorized voucher. The other scheme, the budget system, does not permit the issuance of materials on vouchers. The two plans require explanation.

Formerly foremen and workmen found all supplies open to them for the mere asking. Many shops and mills at the present time may be found wherein the workmen need only to make an oral request, and stock will be given out without further ceremony. In such plants, the storekeeper attempts to make a record by charging the value of the material to the contract on which the workman says he is employed. The scheme is so loose that men frequently obtain many things which they do not use for their work at all. In one instance there were men working on some things which were exceedingly grimy and oily. Their hands became ingrained with the dirt. A happy accident revealed to them that the grime could readily be removed by the application of lard oil.

At some time every day, while they worked on that job, the storekeeper issued to each man about a half pint of the oil, presumably for the contract, but which they actually used to clean their hands. At that time lard oil of that quality cost about $1 a gallon.

No one who has tried the plan of unrestricted issues has found it satisfactory where the raw products possess any exchangeable or usable value, outside of the shop. Losses in

WORKS REQUISITION ON STORE ROOM

_____ 191

STOREKEEPER.

PLEASE DELIVER TO _____

The material listed below and charge to

CONTRACT NO. _____

QUANTITY	DESCRIPTION	VALUE* PER UNIT	TOTAL VALUE

APPROVED _____ FOREMAN

*For cost clerk only

Size 3″ x 5″

FIG. 47.

stores were found to be inevitable, and it became customary to give out stores only to workmen having authority from the foreman in charge of the department, or from some other authorized agent. In order to carry out this scheme, shop accountants devised the plan of putting in the hands of the foremen regularly printed requisitions ruled much like Fig. 47.

A workman desiring anything for his job, applies to the foreman or his clerk, who fills out a blank, stating the material, with the amount which he wants given to the man, and

then signs the slip. The storekeeper with this authority issues the requested goods. In small shops, where the foreman has comparatively few things to look after, this scheme can be used with excellent results. Men will not call for goods or supplies which they do not need, since the foreman, being held responsible for all goods given out over his signature, is not likely to authorize the order without good reason. When, however, a shop becomes large, the foremen are apt merely to sign their initials in approval of requisitions made out by the men. There are shops which use the requisition system with very poor results. In one plant where this scheme was in operation, the men were building some machinery which required the use of candles. One or two of the workmen found after a few trials that the foreman gave his approval without trying to remember whether the materials had been duplicated in a previous voucher, and without giving much attention to the items in the list. The O.K. mark was given in a perfunctory way, thus the workmen could get the goods by going through a mere formality. Two men every day made a regular practice of getting some half dozen candles each, which they put in their dinner pails and took home. Others obtained brass by the same method, others incandescent lamps, and the storekeeper, who would ordinarily have been able to check these losses, was unable to do so because there were, on an average, several hundred requisitions daily. It kept all the store's clerks busy delivering the amounts authorized without doing anything more, even had they felt so inclined.

In a large shop it is asking too much of the foreman to expect him to look after such leaks. His main work should be to see that the men are supplied with the equipment to do the work, that everybody is being properly employed, and that the work is going along with the least possible friction. If he is asked to do anything else, these important matters must suffer. The storekeeper can hardly be asked to pass a

judicial decision as to whether or not a man should have the supplies called for on a properly authorized voucher. If he is expected to go back of the voucher, then it is he and not the foreman who really has the authority to issue goods. This would entail endless friction and needless waste of time, and would cost more than the saving would be worth. The fault is not with the men, but with the system.

Since the requisition system fails in checking losses, a number of shops have sought for some other device. The requisition system would have succeeded had it been possible to prevent orders being made out for more than the requirements of any job; because the storekeeper can be held responsible for all over-issues, though the foreman cannot. The problem was to introduce a system that could utilize the storekeeper's possibilities and obviate the need of depending upon the foreman.

In order to construct a large engine or electrical generator, engineers must carefully draw up plans months in advance, and must show to the utmost detail everything which enters into the firm's product. In these plants the great losses have occurred through the requisition system. In textile plants and continuous industry plants the voucher system has been very successful in stopping all unnecessary waste and losses. In other concerns, however, where it has not proven a success, the managers can use the very disadvantages of the work to aid their purpose. In the drawing-room after the drawings and plans are all completed, clerks go over the drawings and make lists of the material which goes into the finished product. This must be done in order to let the purchasing department or agent know just what to buy. Copies of these lists of materials are sent to the foremen of the various departments so that they may know what to prepare for in the forthcoming new work. Someone hit upon the happy device of having several copies made of the lists of materials. One of these was given to the storekeeper. The list for each

contract is ruled as in Fig. 48, and is given to the store clerk with the following instructions: "Issue material to any responsible workman who calls for it, provided the goods are listed on the sheet, but take precautions to get the workman's number against every amount of goods he takes out. When the list has all those items checked off, issue no more goods unless spoiled material is returned, or some satisfactory explanation comes from the foreman over his signature as to why the extra material is needed."

This is the budget system, and it has a number of advantages.

1. It absolutely prevents stealing, because no one gets goods unless he is responsible for them.

2. It lessens waste to a remarkable degree, because any unnecessary calls for material are at once noted, and require much careful explanation as to why they are required, and men are not apt to be careless when they find their actions subjected to such close scrutiny.

3. It inevitably brings scrutiny and questioning when the loss occurs. A man cannot shift his responsibility.

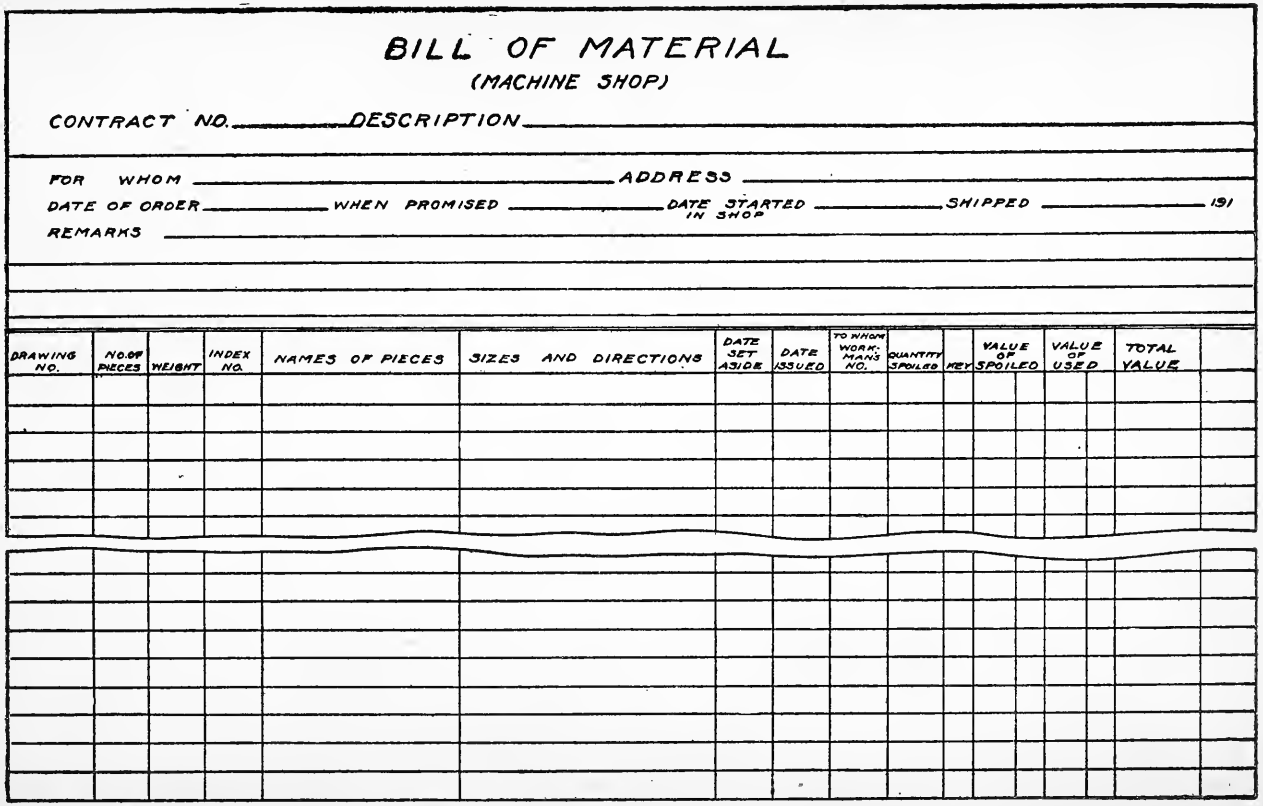
4. It enables the storekeeper to tell well in advance just what materials he needs, so he can get ready for the demands.

5. It lessens the accounting, because it eliminates the handling of the vouchers, their listing and adding at the end of every day. In fact, the storekeeper can make up his books days in advance if he so desires.

6. It enables the people in charge to keep close watch on all material, because by it one can predict what should be the condition of the stock at any time; and, if it is not in that condition on the appointed day, explanations must be made for shortage in stock or for delay in completing the contract.

To be sure, it has some disadvantages.

1. It cannot be operated successfully unless the actual



BILL OF MATERIAL

(MACHINE SHOP)

CONTRACT NO. _____ DESCRIPTION _____

FOR WHOM _____ ADDRESS _____

DATE OF ORDER _____ WHEN PROMISED _____ DATE STARTED IN SHOP _____ SHIPPED _____ 191

REMARKS _____

DRAWING NO.	NO. OF PIECES	WEIGHT	INDEX NO.	NAMES OF PIECES	SIZES AND DIRECTIONS	DATE SET ASIDE	DATE ISSUED	TO WHOM WORK. MAN'S NO.	QUANTITY SPOILED	KEY	VALUE OF SPOILED	VALUE OF USED	TOTAL VALUE	

Key. W. Bad workmanship M. Poor material, D. Defective directions
Index No. is used in connection with Fig's (70) and (71) to locate firm who sold poor material.

SIZE 18" x 11"

FIG. 48.—Budget Blank for a Machine Shop.

amounts of material needed for any undertaking can be closely estimated.

2. In special emergencies it does not work fast enough.

On account of the former defect, shop managers use a modification of the budget plan to keep a watch on materials like oil, waste, and things which cannot be definitely allotted to jobs. An approved plan in use to prevent extravagance is to issue to each man a certain amount of these materials every week, and give him no more until the next distribution day. One firm adopts the scheme of giving the floor hands a couple of pounds of waste every Saturday, and permits them to have their oil cans filled on certain scheduled days. Those who have charge of the machines are given different allotments, and are permitted to get oil at any time they desire.

In a shop where large work, made up of many parts, is being handled, or where there is a great number of regular orders going through daily, the budget system is without question the most efficient material record that can be devised. There are conditions, however, when the system becomes an annoyance and expense if literally carried out. Suppose, for an extreme instance, that an urgent repair job is brought into the shop about Saturday noon, after all the clerks and draftsmen have left until Monday morning. To wait until the complete lists of materials are made out for such a case would be stupid folly, for the plant which needs the repairs will want to be running by the time the clerks would ordinarily have the budget ready to send into the shop.

For repairs or special rush orders of any kind, a good plan to prevent loss of material and at the same time get the work out in a hurry is to give the foreman or some responsible official in charge of the departments the privilege of making special requisitions for such emergencies. After the contingency has been taken care of, the special requisitions can be assembled and the amount of used material accurately

determined and priced. If, on comparing the issues and costs, as shown by these special vouchers with similar repair jobs or ordinary output, it is found that the issues have been unusually large, an investigation should be made and explanations sought. While such inquiry does not of course prevent loss or waste on a contract that has left the shops, it tells the management who is responsible for losses, and if the man at fault does not prevent future overissues, he should be discharged.

These unexpected difficulties are apt to arise at any time, and no system can be devised to take care of them all in the ordinary routine, without either delay or friction, or both. For such instances every system should provide some short cut, as above outlined. It is under these conditions that the manager proves his worth. In fact, he is not really capable of filling his position unless he knows how to make short cuts at the proper time, and just when he should modify his standard system, whatever it may be, to take care of unexpected events.

CHAPTER XVIII

RECORD OF FINISHED AND UNFINISHED GOODS

After providing for keeping track of the labor force and of the raw materials, there still remain the partly finished goods, the finished goods, and the machinery, including equipment. It is necessary to keep track of the partly finished goods for several reasons:

1. To keep the management informed as to the probable time when various goods will be ready for delivery.

2. To keep track of the approximate value of the goods at any time.

3. To determine whether departments are over or under equipped with men and machinery.

4. To enable the management to determine the value of a new contract and to localize waste in production.

First, it is necessary to know the approximate time when deliveries can be made, in order that the company may be able to satisfy customers as to its ability to deliver goods.

Second, it is highly desirable to know the value of any goods up to their particular state of completion, because it enables the management to determine what are the most expensive steps in the process, and makes it possible to determine in case of fire what his losses have been in partly finished goods.

Third, it is well to know which are the undermanned and equipped and overmanned and equipped departments with relation to each other. One cannot be too careful as to the way in which money is spent to balance the plant. If a concern does not know its strong and weak points in production,

it is in danger of spending money uselessly or of giving appropriations to some well-equipped department for further improvements, which it really does not need and cannot use because of the condition of the rest of the plant. True economy does not consist in buying the latest improvements in machinery unless the whole plant is fully capable of utilizing the improvement to the best advantage.

Partly finished products give rise to a complicated problem of accounting. Goods bought at a certain price as raw material have their value constantly increased by the addition of labor, power, and of certain costs in the form of overhead expenses, insurance, reserves for depreciation, interest, and the like. One day the goods are worth little more than the raw material. A week later they may be completed. If a particular kind of product is being manufactured, various amounts of a large order are worth different values at the same time, because the material is going through in lots, so that it is not in the same state of completion at any given period.

From the standpoint of the nature of orders sent into plants, there are two kinds of manufacturing possible:

1. For a general stock from which the goods are taken as the sales are reported. Examples of this type are furnished in the making of hats, shoes, textiles, furniture, pianos, and almost all ordinary goods consumed in a community.

2. For a specific contract, as illustrated in the production of locomotives, large machinery, steamboats, and in building operations.

If it be desired to keep close watch on all the goods in the partly finished state with their degrees of completion, there must be a perpetual inventory or record of unfinished work. To accomplish this, it is necessary to carry into effect two ideas that have been found imperative elsewhere for the attainment of successful management:

1. Divide the plant into departments.

2. Use the production order and have each finished operation reported by departments to the accounting division.

The departmental method of running an organization is to divide the establishment into a number of sections. Each division is under a foreman, who is held responsible for a certain number of steps in the process of manufacture.

The production order is an instrument, or a series of instruments (see Figs. 35 and 36), made out by the central authority, presenting in written form the instructions to be followed in various departments of a plant in order to produce a given commodity. It may or may not be a part of a voucher or budget system. The production order, in its strictest sense, only tells what things shall be done; it does not necessarily keep track of material used. However, wherever a production order plan is used, it almost always combines with it some kind of a material record, and whenever the budget system is put into operation, it invariably uses some form of the production order. This instrument follows the goods through all the departments in the manufacturing process; and as they pass from one to the other, the order can be made the basis for keeping record of the work as it progresses through the plant. To do this, one need only require each manufacturing division to notify the accounting office of the number of production orders received and the amount of work expended on each order during the day. This can be done in connection with the material budget and time-check system, and in fact is usually a part of the time-record scheme.[1] In this way the officials of the concern have a constant exact record of the value of goods in the process of manufacture.

The simplest type of plant is one which manufactures a product like sugar or refined oil. The product comes into the plant in a bulk that can easily be measured, and is

[1] See Chapter XVI.

passed from one department to the other, either by pumps or gravity. The quantities can be definitely measured, almost if not quite automatically, at the end of each step in the process by simple registering devices on the tanks, conveying tubes, or receptacles. Nothing need be handled. The only attention required is to see that the machinery is in

BAG FILTERS

Workman No. _____ _____ 191

Tank No. _____

Mixture No. _____

COSTS*

Labor	Gross	Per lb.
Prod.		
Unprod.		
Fixed Chgs.		
Special		
Total		

* For Cost Clerk only

SUGAR DELIVERED				
CHAR. PURIFIERS			SWEET WATER	
No.	Amt. Gals.	Spec. Grav.	Amt. Gals.	Specific Gravity

SUGAR RECEIVED		Amt. on Hand		Time Hrs.
Gals.	Specific Gravity	Gals.	Sp.G.	

FIG. 49.—Record Slip showing Amount of Goods which passed through a Department in Bulk.

condition. Of course, there may be wastes in the chemistry of the process; but, if these are once revealed by the scientist, the measuring gauges can be made to show their importance.

In such a plant, the task resolves itself into making a permanent record of the product of each department, as shown by the weighing of the solids and the readings of the registers on the tanks, stills, boilers, and other holders of the liquids, and the length of time each amount took to pass

through every particular step in the process. If these slips (see Fig. 49) for each day's work are sent to the cost clerk, he can add the direct labor cost on each portion of the product; and can apportion the percentage that the said department carries of the managerial expenses—rent, taxes, interest, depreciation, repairs, and the like, and thus determine unit costs. Each department can be required to fill out forms like Fig. 49, and, at the end of the day, send them to the cost clerk, who can enter them on a cost ledger sheet, ruled something like Fig. 50.

In a plant of this character, where nothing is sold except from general stock, it is desirable to know what has been the amount of waste in different mixtures, as well as their stage of completion within the plant. The former can be determined very readily by making note of the total amount of the various ingredients of the mixture, and noting at the end of the process the total amount of the different kinds of finished products obtained from this mixture. If accurate ledger record is kept of the material as it passes from one step of the process to the other, one can tell, by merely looking on this summary page, the amount that has been received, the amount that has passed through, and the balance on hand. One can also tell the extent of the loss that has been entailed in purifying the product to any particular degree. If, at any time, a new order should come in for a lot of material, or if a cargo of new raw material should be delivered, the manager of the plant can turn to the ledger sheets and ascertain just what is the condition of the orders under way, and how soon he can utilize the raw material awaiting his disposal, or how soon he can deliver any unusual orders. The ledger can also tell him whether or not one department is smaller in capacity than it should be to bring about the best results for the firm. In fact, the ledger, if well kept, affords just as accurate an inventory of goods in process of manufacture as of the raw materials.

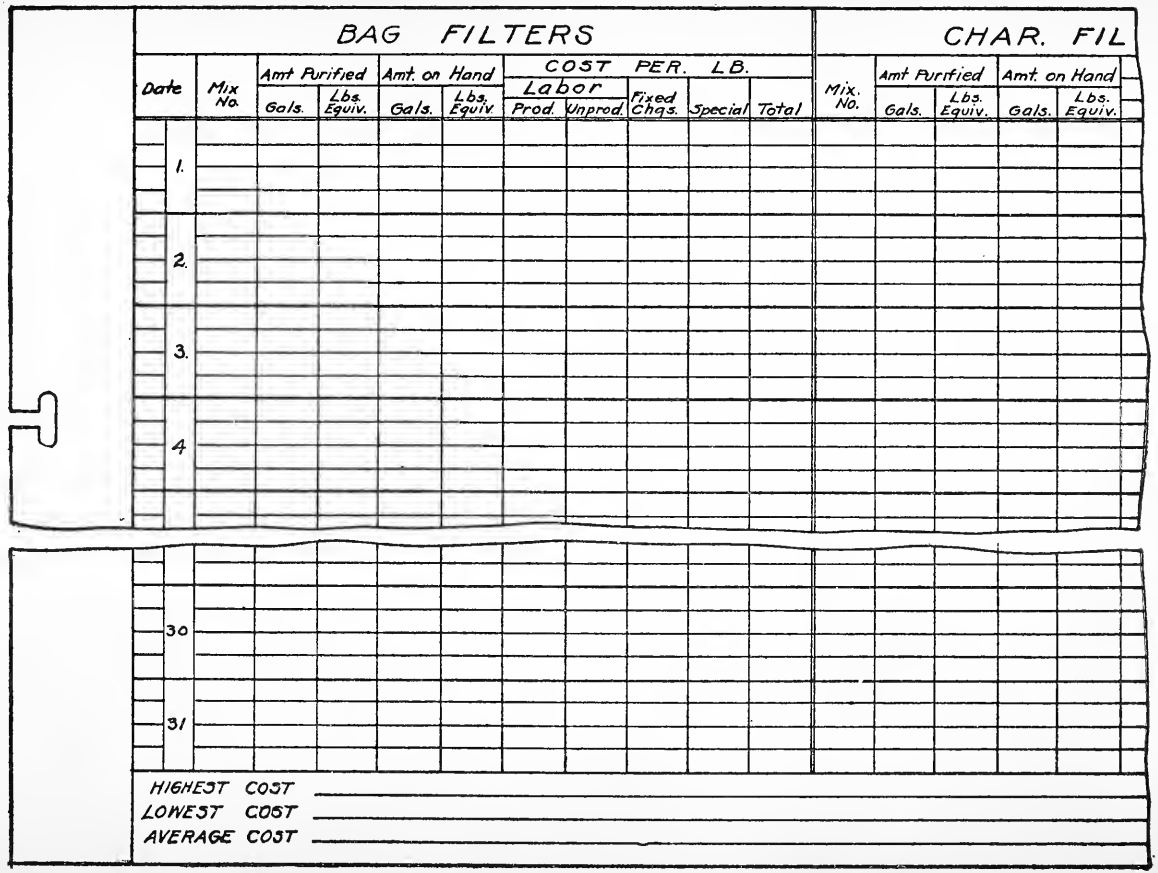


FIG. 50.—Combined Cost Ledger and Partly Finished Goods Record for Goods which pass through Departments in Bulk.

In the manufacture of hats, shoes, furniture, and similar materials, there is a more difficult problem. The product cannot be measured in bulk, and the time taken to manufacture cannot be recorded for each lot in a group way. The commodities are made up of pieces which must be handled as units, and the steps in fabrication are such that each product must be acted upon separately by the attendant at each machine.

A good way to keep account of products of this type is to pass them through the factory in small quantities. Hat factories, shoe establishments, and textile mills divide their products into lots which may include pieces of so many yards, or comprise one, two, three, or more dozens units or pairs. A production order is written out for each lot of goods, and two methods may be used to record the exact condition of the lot in the process.

1. The production order may be arranged in the form of a tag having detachable slips. (See Fig. 35.) As each operator finishes his step in the process, he detaches his portion of the tag, and sends it to the accounting department, where all tags are summarized on a partly finished goods record sheet for goods which pass through departments in lots. (See Fig. 51.) To determine what is in each department by Fig. 51, one need only note the number of lots which have been received, but which have not been passed on to another machine or step. If one of the departments has received a great number of lots and does not seem to be delivering them as rapidly as they are turned in to them, the management can at once search out the reasons, which may be lack of men, insufficient machinery, or may need more ability on the part of the foreman to get the work out.

2. According to the other scheme, a tag or slip is made out for each operation (see Fig. 36), and every day the foreman of each division makes a list of the jobs he finishes and then gives this record to the accounting department. In the

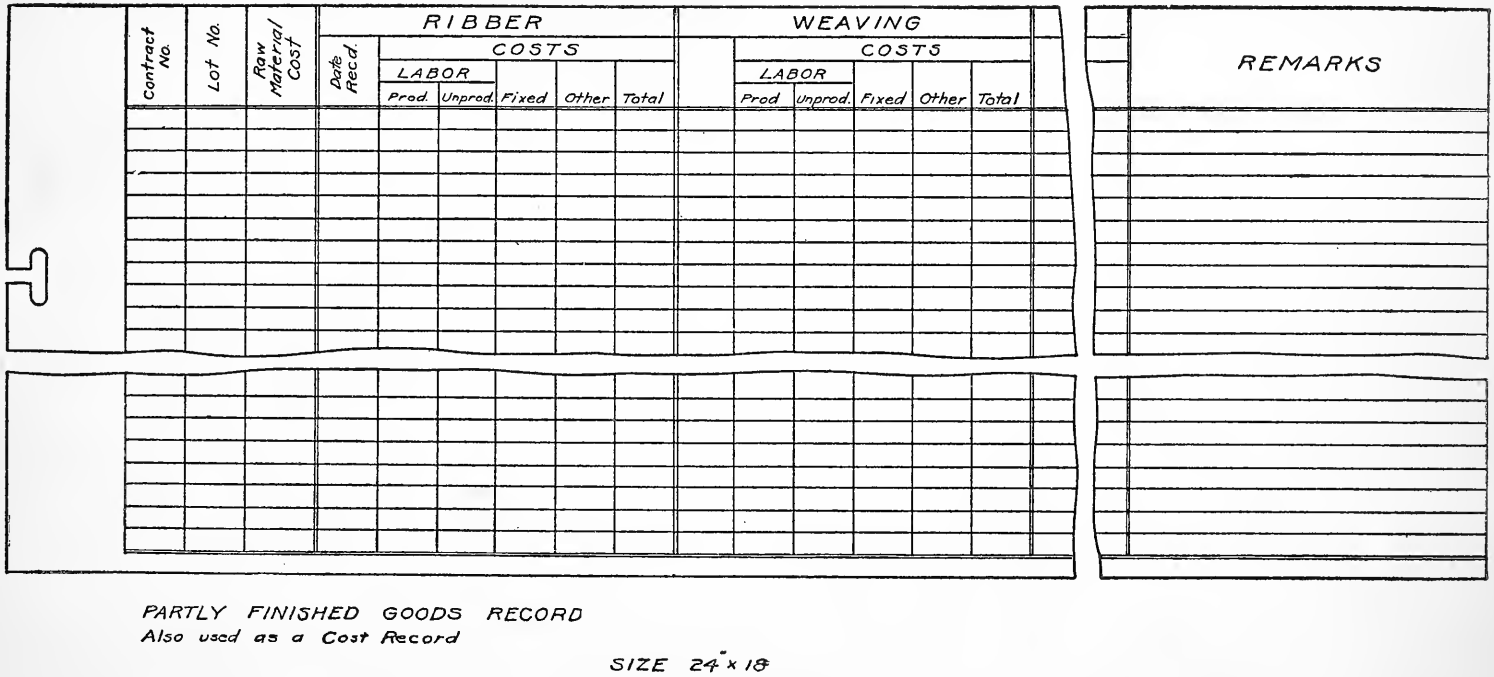


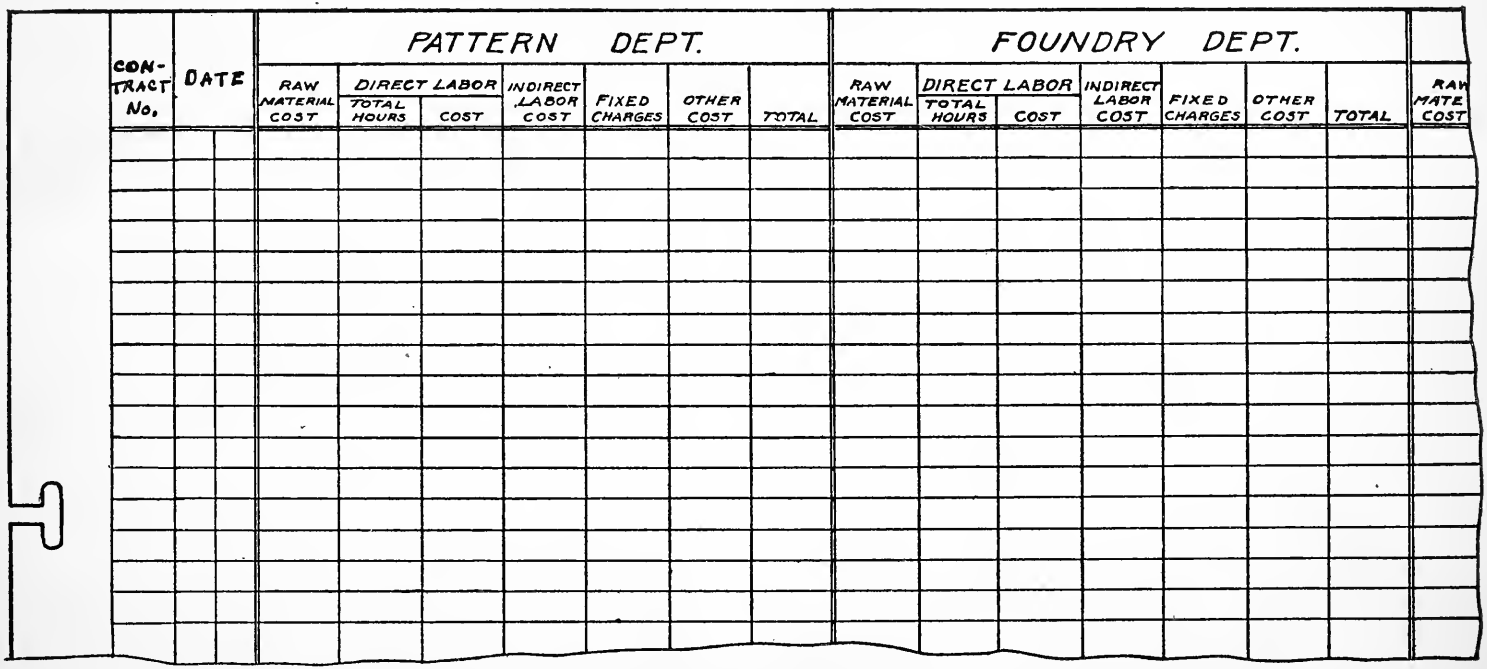
FIG. 51.—Partly Finished Goods Record. As the sheet is ruled, it can be used to keep track of special orders. If the plant does not manufacture for special orders, the column headed "Contract No." should be omitted.

accounting department these totals may be summarized on a sheet like Fig. 52. This sheet gives the head of the plant a good idea of what is going on. Some firms use this balance scheme to very good purpose. A certain large wagon manufacturer calls together all of his foremen every day, and has them list on a big blackboard their receipts from and deliveries to every other department, with their balances on hand. If any foreman is short of goods or runs below his standard amount of receipts, he records his deficiencies in red chalk. If his receipts and balances of goods are unusually large, he records them in blue chalk. The result is that each foreman knows what every one else is doing; and the manager of the plant having all the foremen together, can discuss with them why they are deficient. If anyone is to blame, the difficulty can be located at once, and remedied with remarkable lack of friction. This latter scheme of handling material can be used very effectively in assembling processes.

This chapter has advocated the use of the production order form of tag or slip, to gather the time of each contract on the summary books. (See Figs. 35 and 36.) While this is in most cases the best scheme to employ in machine shops and similar plants, these ledgers can be used in connection with other kinds of time-slips like those illustrated in Figs. 31, 33, and 34, or even with the daily contract time-book (Fig. 29).

The work of gathering the material on the ledger sheet is practically the same in each case. A ledger sheet of this character shows the length of time the work has been in each stage of the process, and gives the management some idea when it should be finished.

The general question of cost accounting is not under discussion here, but if records are kept in the manner indicated by the chapters on keeping track of the labor and keeping track of the raw material, it requires little or no added expense to fill in the column shown on these ledger sheets for



Allow 3 inches for Remarks Column at extreme right.

FIG. 52.—Combined Partly Finished Goods Record and Cost Ledger. This sheet is for use in plants which manufacture engines and other kinds of machines for special contracts.

determining exact labor and material costs. Indirect expenses and power costs will have to be apportioned from the general books to the plant's output.

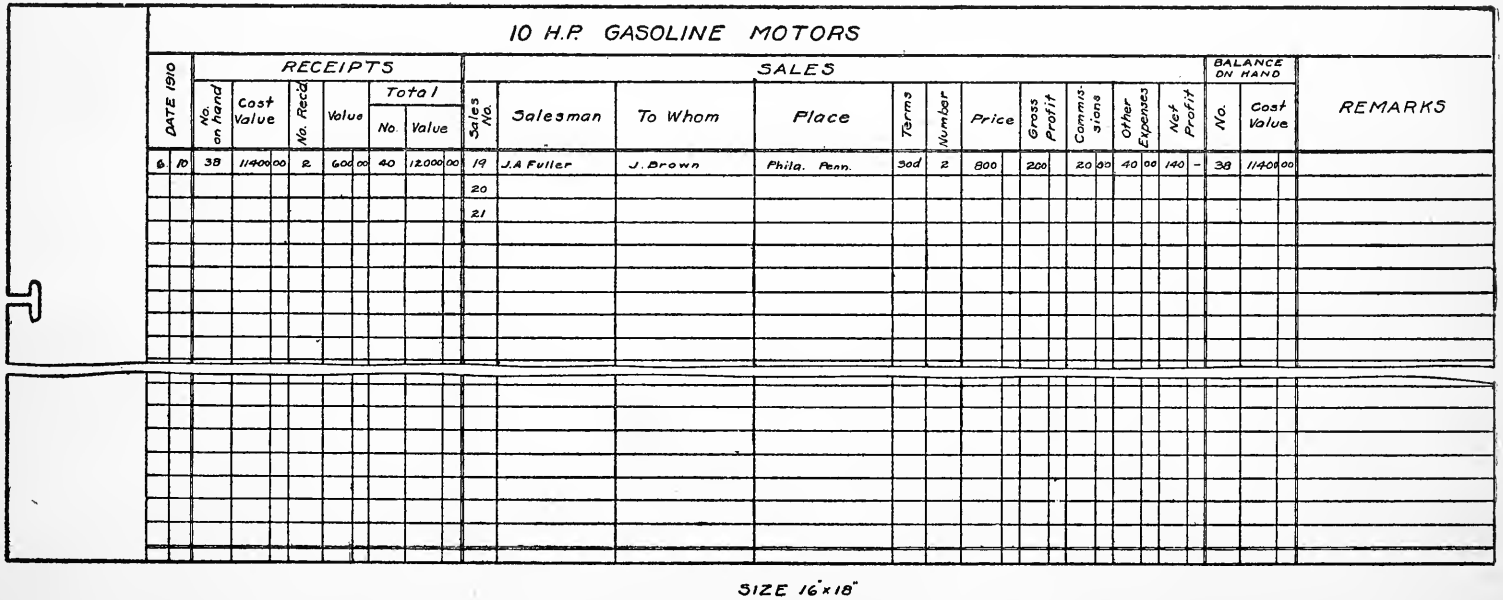
To keep track of the finished product, little need be done. In ordinary enterprises the shipping department receives all its finished goods from its own factory. Some businesses are of such a nature that the product is shipped as soon as it is completed; but where stock is kept on hand, the keeping of an inventory is quite as important. The following formula suggests an efficient method of keeping such an inventory:

[Amounts received from factory (both quantity and value) + Balance already on hand (quantity and value) + Returns (quantity and value)] — [Sales (quantity and value) + Amounts given out, but not sales, as gifts, etc. (quantity and value)] = Inventory on hand (quantity and value) or $(A + B + R) - (S + G) = I$. (See Fig. 53.)

To make any inventory thoroughly reliable, an adequate system of original records should be provided in addition to a proper summary record in the ledger. A very good plan is to have the shipping department give a receipt for every consignment of goods received from the factory. The receipt should be made out in triplicate, one copy being retained by the foreman of the factory, one by the shipping department, and the third sent to the accounting department, to be used as a basis for the ledger entries, and to be filed away for reference.

When the shipping department receives goods returned from dissatisfied customers, or from any other source than the factory, another form of receipt should be made out in triplicate, one to be sent to the customer or source from which return comes, one to be retained by the shipping department, and one to be sent to the accounting department.

The shipping department should send goods out only on receipt of an order from the sales department. The sales or-



10 H.P. GASOLINE MOTORS

DATE 1910		RECEIPTS						SALES													BALANCE ON HAND		REMARKS
		No. on hand	Cost Value	No. Recd	Value	Total No.	Total Value	Sales No.	Salesman	To Whom	Place	Terms	Number	Price	Gross Profit	Commissions	Other Expenses	Net Profit	No.	Cost Value	
6	10	38	11400 00	2	600 00	40	12000 00	19	J.A Fuller	J. Brown	Phila. Penn.	30d	2	800	200	20 00	40 00	140 -	38	11400 00	
								20													
								21													

SIZE 16"×18"

FIG. 53.—Combined Sales Record and Finished Goods Inventory.

ders should be made out in triplicate, the original to be retained in the sales department, duplicate and triplicate sent to the shipping clerk. The shipping clerk will fill out the order so far as possible, checking off all the items he has been able to deliver. He will file the duplicate for his own reference, taking care to notify the sales department of any inability to fill out all the requirements of any order, and will send the corrected triplicate to the accounting department, where it will be used as an original record for the ledger credits.

Ledgers of this character can be used for every kind of work. They give the management an accurate statement of the various kinds of finished product on hand at any time, and are an aid in determining future policies in manufacture. If goods are not being sold rapidly, the reasons can be investigated to ascertain whether slow sales are due to laxity on the part of the sales department, or to inferiority in manufacture. Ordinarily, a large percentage of returns indicates the latter cause, and a careful investigation will reveal the true cause of the plant's deficiency.

CHAPTER XIX

RECORD OF EQUIPMENT

The equipment of a plant may be separated into four divisions:

1. Hand tools and machine attachments used by the workmen in the course of their work throughout the day.

2. Patterns, templets, and other forms used for special classes of work or for special occasions.

3. Drawings, records, and plans.

4. The power machinery which makes goods under the direction of the workmen.

In keeping track of each of these four classes of material, a different principle is involved. The tools of the first class are used constantly, and to keep track of them, they must be put in a place convenient for the workmen. The tools should be so arranged in the tool-room that anyone can find them at once, even if he is a comparative stranger to the room, and the system of accounting for stock must enable the storekeeper at any time to tell who has a tool out.

As has already been stated, the best situation for the tool-room is near the center of the shop. If, however, there is any great difference in the rate of wages paid to the men, it will be cheaper to place the tool-room nearer to the machines at the section of the shop where the most skilful and expensive labor is situated. Frequently, however, the highly paid workers have one or more helpers, so our rule will again have to be modified. It is the workmen who have no helpers, and yet are highly paid that should be nearest the tool-room.

1. To keep track of the tools within a tool-room in such a way that anyone can find them is not so difficult a task as

it might seem. In a plant like a textile establishment which has really little if any need for hand tools, the tool-room is small and unimportant, and almost any system suffices that makes it possible to know who have possession of the tools; but in a machine shop where there are a great many small tools and attachments for machines, hammers, chisels, drills, wrenches, taps, dies, gauges, and a hundred other different kinds of instruments constantly in greater or less demand, a convenient system must not depend upon the memory of any one or of several individuals.

Two systems are in general use to keep track of materials in machine shops:

(a) The tools may be arranged in classes and groups. By this scheme, all cutting tools are kept together in the cutting class, the machine cutters being put in a group by themselves, while the hand-cutting tools are grouped separately. Within these groups the tools are arranged according to their use. If they bore holes, they go under boring cutters; if they cut grooves or flat surfaces, they are plane-cutters. They are also arranged in order of sizes. One firm carries out this scheme to a very elaborate extent.

The tools in the tool-room should be kept in good condition by the tool-shop. The workmen should be relieved of the necessity of grinding or caring for them. There should always be a large supply of the more commonly used tools, and at no time should a workman fail to obtain a tool when wanted. There should be no red tape necessary to get a tool. The workman should be held responsible for a tool after he has received it, but should not be put to any unnecessary trouble to get it.

According to the plan outlined, accuracy in record and availability for use can be achieved by stamping on the tools their proper letters, so that one, even a stranger, need only look for the drawer or compartment bearing the same letters, in order to put them away in their proper place.

(b) The other scheme is to classify tools by numbers instead of by letters or any mnemonic sign. According to this plan, every tool is indexed, and a person desiring a particular one, turns to the index, finds its number, and goes to the corresponding case or drawer. There is little difference in the principles of the two schemes. Both permit the tools most generally used to be stored in convenient places, and they also keep all tools of the same class together.

Quite as important as being able to find the tools in the tool-room is the ability to tell where the tool is in the shop. Many tools are used intermittently, and numerous duplicates are unnecessary. Large wrenches are required on big jobs, but even the largest shops do not need to have many duplicates, provided the tool-room clerk is able to tell where a tool is at any time. A good device is to give the workman a set of brass checks stamped with his number, so that the tool clerk may put a check in place of the tool which the workman has secured. This check acts as a receipt for the tool, and is not to be returned to the workman unless he delivers the tool to the clerk. If a workman calls for a tool not on hand, the tool clerk can promptly tell who in the shop has it. The workman may then borrow the tool, or leave his check with the toolkeeper, get the other man's check and exchange it for the tool. The second workman might also go directly to the first man and exchange a check for the tool. The next time the first workman goes to the tool-room he can exchange this check for his own.

By this simple scheme shops can keep track of all tools while out of the tool-room. With the check system, workmen can be made to deliver all borrowed tools before they permanently leave the plant, because they can be compelled to return a full complement of checks before they will be given a clearance paper from the tool-room.

The system indicates who has any particular tool out at any time, but it does not show how many tools any particular

workman has. If it is desirable to keep track of this, the tool clerk can have a list of the workmen's numbers, and enter therein the numbers of the tools each workman takes out. There are so few advantages, however, in having this information that it is seldom, if ever, recorded. In some cases expensive or special tools, as a diamond-cutter, may require a special receipt from the workman, but otherwise the tool-room clerk can keep sufficiently close watch on the tools a man has out by keeping record of the checks a workman has lost, and by noting his calls for any tools which would be unusual for his particular work in the shop. If the man is about to leave and has lost checks, the clerk need merely refer to his memorandum, and insist that all other checks be accounted for by tools. This may seem a free and easy method for one to keep track of thousands of tools and hundreds of workmen; but, as a matter of fact, the fine that is attached to the loss of checks makes it unprofitable for a man to take tools which are not extremely valuable in their nature, and in those cases the special receipt is ample protection.

Besides keeping the tools convenient to the men and keeping track of them in the tool-room and in the shop, the tool department should be able to report to the management the kinds and makes of the most serviceable and profitable tools. A convenient and reliable scheme is to have stamped on the shank of the tool, or in some inconspicuous part, the date of its purchase and the cost mark; and, if it is not already there, the name of the firm which made it. If this plan is followed and care is taken to issue the tools under comparison, an equal number of times, the management can soon tell which makes are proving the most efficient and economical. It can also determine from this record what is still more important: the actual expenses connected with the tool department and what classes of work are the most expensive users of tools.

2. The second class of equipment—patterns, jigs, templets, and other forms and guides for the workmen—are not important in many lines of manufacturing. In many others, however, they are used almost continuously. In some classes of production the forms or patterns must be renewed every year or so, not because they are worn out, nor because the firm ceases to manufacture goods of a similar grade, but simply because the whim of fashion has called for something else a little different in shape or form. In the shoe industry the question of lasts is troublesome. Some factories sell their lasts to concerns that manufacture a cheaper or lower grade of shoe, and hence do not cater to the more fastidious public. Even when lasts are sold, they are sold at a loss to the concern. Eventually every shoe manufacturer must sacrifice a great deal of money yearly through the discontinuance of certain styles and the introduction of others. Great as this loss is in total amount, it does not put a heavy burden on any one pair of shoes, because a concern manufactures thousands of pairs in a year, and the money expended upon the lasts is distributed through so many pairs of shoes, that it adds but little to the cost price of the shoe.

Other industries find patterns and forms just as essential as does the shoe industry. An engine cannot be built without using many expensive patterns and forms of various kinds, and general machine shops rapidly accumulate a large number of patterns. The drawing-room receives the specifications for all contracts, and it can make possible heavy savings in using old forms and patterns if they happen to know of previous jobs whose patterns can be adapted to the new undertaking.

It is important for the drawing-room to know just what patterns it has at any particular time. Few engines made at different times are exactly alike, yet every new engine must have a complete set of patterns, which will in all probability never be duplicated. The patterns may represent

several thousands of dollars in labor and materials, and be useful for only one contract. It is not to be assumed that these patterns represent a dead loss, for, although they may never be used again as they stand, they can frequently be utilized for other orders by making alterations. Because they may be adapted to other work, manufacturing firms always keep patterns, whether the work is likely to be duplicated or not. If a plant has been in operation for some time, these patterns may accumulate to embarrassing proportions, and unless there is some system of registration for them and the drawings which they represent, duplications and partial duplications of these forms will constantly occur and occasion large losses. Companies early began to develop plans for cataloguing drawings and patterns.

3. One scheme was to classify the drawings by the number of the contract, and to list the name of each by the part of the engine it represented. Thus, a drawing of a high-pressure cylinder of the 121st contract would be entitled "high-pressure cylinder," and in some less prominent place on the sheet would be printed "Contract No. 121." The patterns would be numbered in a corresponding manner. The system is faulty, because the contract number gives no intimation as to the kind of job represented. Should it happen that the shop turns out water turbines, steam pumps, hoisting engines, blowing engines, and marine engines, Contract No. 121 might be anyone; and since patterns and drawings were filed and stored in order of the number, the disadvantages were many, but the system had in it suggestions for a better one.

Few, if any, contracts go through a drawing-room without the chief engineer and the draftsmen knowing for whom they are intended. Involuntarily the number of the contract becomes associated with the purchasing firm; and the said firm is, in nine cases out of ten, engaged in a particular business. If the company orders a blowing engine, it is in the

iron business, and not likely to call for marine engines. The contract numbers become attached to the firm's work, and the firms become associated with certain classes of machinery. To the men in the drawing-room, a new order for a blowing engine calls to mind the firms which have ordered similar engines in the past, and they recall the contract numbers which have been attached to those firms. This coincidence gave rise to another system of tabulating drawings and patterns, viz.:

To classify alphabetically according to the names of the firms who order. This system is superior to the previous one in that it simplifies the search for drawings of machinery of a similar type, and reduces the probability of drawings being overlooked. To the older men in the office a firm's name suggests the kind of machinery it is in the habit of securing, and they involuntarily start to hunt them up when machinery of that type is reordered. Although in a moderate-sized plant the system is quite satisfactory, in a very large one it fails because new men are constantly coming in who do not know all the ordering firms, nor remember their characteristics. Besides, ordering firms at times radically change their work and call for other things, so that important drawings may be forgotten, especially if there has been any change in the administration of the engine-building company. The system tends to fail because men are compelled to remember too many names, and too much about past orders.

An effective system is to classify the machinery into groups, and give each group a distinctive number. Engines of the reciprocating marine type might all come under 500, if simple engines their number will be 510, if compound 520, triple expansion 530, and so on. Should the steam expansion of the simple engine occur in two cylinders, its number would be 512; by letting the units represent the number of cylinders, a triple expansion engine with five cylinders would

be 535. The arrangement of the cylinders over each other determines the number of connecting-rods, piston-rods, cranks, housings, and the like, which the engine will require. Frequently a five-cylinder engine will have four of the cylinders arranged in pairs tandem, while the fifth will be single. An engine of that character will have three connecting-rods, three cranks, three sets of housings or their equivalent, three sets of eccentric rods; in brief, the engine will be built on a triple basis throughout. These kinds of arrangements could readily be indicated by the addition of decimals. Thus, if a quadruple expansion marine engine had six cylinders arranged—two tandem, two single, two tandem—it could be expressed 546.2112. Should there be any other characteristics that were desired to be shown, it could be done by the insertion of letters, or some other simple device. Thus, suppose the above quadruple expansion engine had surface condensers, they could be indicated by a letter "S" substituted for the decimal, thus 546S2112. A jet condenser would be shown by the substitution of a letter "J" instead of the letter "S."

A system of classification based upon this general outline possesses the advantage of giving easy accessibility to all kinds of machinery of any class made at any time. In addition to its application in the drawing-room, it can be used in the pattern storage houses.

A convenient scheme for the arrangement of the patterns is to apply the drawing-room classification to the placement of the patterns in the storage shed. The drawings above have been numbered according to a certain grouping system, which gives characteristic numbers to each class of engines or machinery manufactured, so that one can tell at once by the number what an engine is like, and much about it. If we divide up the pattern storage room on a basis of that classification, all the patterns for the engines and engine parts would be readily accessible. All engines, although they

may differ widely in their design, structure, and size, have certain parts which are in the main common, as cylinders, steam chests, engine frames, bed plates, shafts, fly-wheels. The patterns may be grouped either by contracts as a whole, or by like parts of different contracts.

The first scheme has the disadvantage that patterns of small and large parts and of dissimilar pieces are likely to

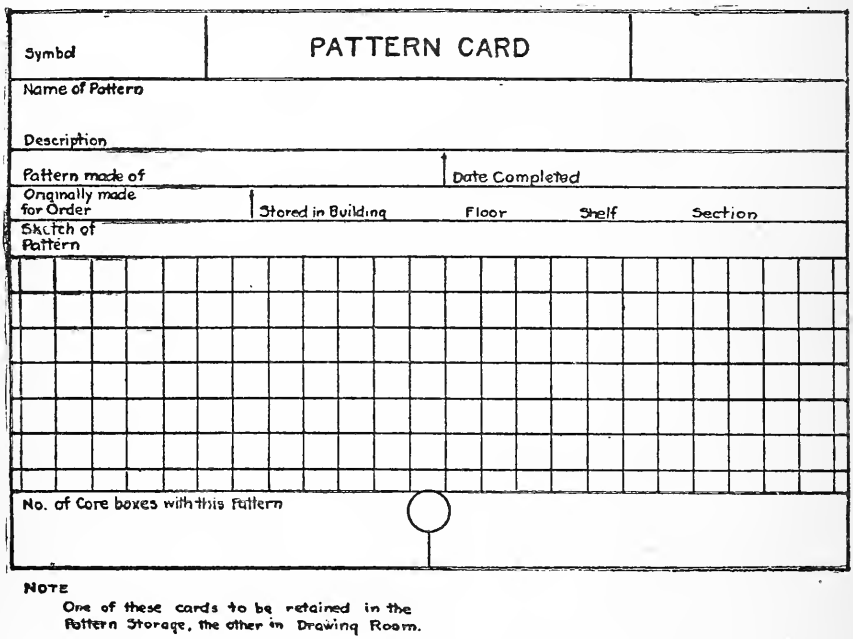


FIG. 54.—Pattern Record Card. (Front.)

be piled together at the expense of good order and of storage space. If all the similar parts of the various machines are grouped together, it is easier to find the same kinds of pieces; and if the system of arrangement is made to correspond to the drawing numbers, the particular patterns can easily be located.

In addition to having the patterns accessible, it is highly desirable that the drawing-room should know the exact con-

dition of each pattern, and where it is at any time. This can be accomplished by having filed in the drawing-room cards which give the number and complete history of each pattern, showing all alterations. Copies of the card may be kept on file in the office of the pattern storage rooms. When the pattern is taken from storage, its card may be removed from the usual filing drawer to another one, so that all the patterns in the storage shed may be in one compartment, while those in the foundry or pattern shop may be in another. (See Fig. 54.)

If, in addition to the scheme of segregating the pattern cards, to show those out of storage the plan to be adopted of requiring everyone who secures a pattern to leave a receipt countersigned by the foreman of the department to which it goes, and of filing that receipt with the pattern card, it becomes a very simple matter, indeed, to trace the pattern at any time. If any alterations have been made on the pattern, the nature of these changes may be entered on the back of the card, so that one will have a complete record of the pattern from the time it was first constructed until it is destroyed.

The principles outlined for keeping track of patterns may be carried out for keeping track of any other kind of material. Some concerns have adopted a filing scheme based on the Dewey Decimal system for their technical literature. The Engineering Experiment Station of the University of Illinois has published several pamphlets showing how the Dewey Decimal System of classification may be applied to Engineering and Architectural work.[1]

According to the Dewey system, all knowledge is sepa-

[1] *Bulletins*, Nos. 9 and 13, University of Illinois Engineering Experiment Station, "An Extension of the Dewey Decimal System of Classification Applied to Engineering Industries," and "An Extension of the Dewey Decimal System of Classification Applied to Architecture and Building."

rated into ten classes, and each class is given one of the hundreds for a number, viz.:

000, General, including Astrology, Palmistry, and Works of a similar character.
100, Philosophy.
200, Religion.
300, Sociology and Economics, the Social Sciences.
400, Philology.
500, Natural Science.
600, Useful Arts.
700, Fine Arts.
800, Literature.
900, History.

Each of these classes is broken into nine divisions with a tenth division for general matter in the class, and each division is in turn separated into nine sections. The sections are again subdivided, and the process may be carried on indefinitely.

"To show clearly the working of the system the divisions of Class 6 (useful arts) and the sections of Division 2 of this class (engineering) are given.

600, Useful Arts.
610, Medicine.
620, Engineering.
630, Agriculture.
640, Domestic Economy.
650, Communication and Commerce.
660, Chemical Technology.
670, Manufactures.
680, Mechanic Trades.
690, Building.

620, Engineering.
621, Mechanical.
622, Mining.
623, Military.
624, Bridge and Roof.
625, Road and Railroad.
626, Canal.
627, River and Harbor.
628, Sanitary: Water Works.
629, Other Branches.

"It will be seen that the first digit gives the class; the second, the division; and the third, the section. Thus 625 indicates Section 5 (railroad engineering) of Division 2 (engineering) of Class 6 (useful arts). For convenience a decimal point is inserted after the section digit. Further subdivision is indicated by digits following the decimal point. For example, 625.2 is the number indi-

cating rolling stock; 625.23 passenger cars; 625.24 freight cars, etc.

"*Uses and Advantages of the Classification and Index.*—The decimal classification may be used to advantage in the indexing and filing of notes and memoranda, clippings, general information, articles in technical journals, drawings, catalogues, or books. For this purpose the decimal system possesses certain important advantages over the alphabetical system.

"(1) It groups allied subjects. For example, suppose the alphabetical arrangement to be applied to a case of catalogues. The catalogues of the various machine tools, as planers, lathes, drills, hammers, etc., would be scattered throughout the case. With the decimal system, on the other hand, all these catalogues would be grouped together under the class number 621.9.

"(2) Unless an elaborate system of cross reference is used, the alphabetical scheme is ambiguous; in many cases there is doubt as to what letter should be given a subject. For example, take the item "Automatic pneumatic block signals." This might almost equally well be indexed under A, P, B or S. With the decimal system this item has its one number 656.256.4.

"(3) The decimal system has the advantage of flexibility and an indefinite capacity for extension. For the indexing of books and catalogues only the main division and sections will, in general, be found necessary; but for card indexes of technical literature the most minute subdivisions must ordinarily be used. In individual cases, the user may find that still further division is required. An extension may then be made by adding another decimal place, and if still further subdivision is required still another digit may be used.

"The average engineer, for example, can easily index all matter relating to traveling cranes under the single class number 621.872. The designer or builder of cranes may, however, have so much matter relating to this special subject that further subdivision is needed. By the addition of a digit, this matter may be divided into nine groups, designated by 621.872.1, 621.872.2, etc.; and, if necessary, each of these may be divided into nine new groups."[1]

While this system works well for the filing of books, clippings, and drawings, it has its limitations when used to ar-

[1] *Bulletin*, No. 9, University of Illinois, Engineering Experiment Station, pp. 2 to 4.

range contracts and patterns. Manufacturing firms, as a rule, have specialized their work to such an extent that it is unnecessary for them to have any general class number like 621, to let them know their contract deals with mechanical or electrical engineering machinery. For locating patterns, such numbers are not only unnecessary in the average shop, but are confusing; hence, while the Dewey system of classification is excellent for filing all information which the firm may gather from outside sources, a simple modification like the one above suggested, may be used to advantage in cataloguing patterns and contracts.

4. In order to keep a sufficient record of machines, the management should know the following:

(a) Are the machines running to their full capacity all the time the workmen are attending to them?

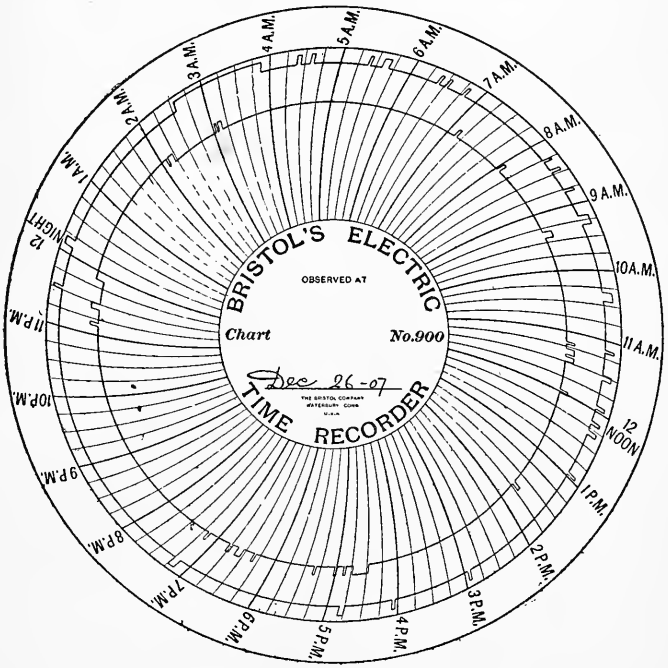
(b) Are there sufficient machines to do the class of work required by the shop?

(c) What is the up-keep cost of the machines in repairs, lost time, etc., and the reasons for these expenses?

(d) What is the rated and real capacity of the machines?

When a company purchases a machine, the salesman is quite apt to make extravagant statements concerning the performance of the device, and the apparatus often proves to be far less efficient than one would conclude from the salesman's representation. Manufacturers have frequently been inclined to discredit salesmen's promises fifty to one hundred per cent. In many instances such action is unfair to the salesman and to themselves, because they may not have gotten the possibilities from the machine, and may blame the salesman for misrepresentation while their own workmen are at fault. The lack of output may be due to prejudice against the device on the part of the workmen, who, to prevent changes in wage rates, will not make the machine produce to its utmost. Sometimes they feel that the output from previous machines is sufficient, and that the new machine is

to be considered a labor-saver, in the sense that it will save them from exerting themselves, as formerly, in order to make the old standard output. The old way of managing a shop compelled the foreman to be alert to prevent machine hands from soldiering. If the boss is familiar with all the ma-



By courtesy of The Bristol Company, Waterbury, Conn.

FIG. 55.—Record Card of a Bristol Automatic Time Recorder Applied to Two Paper Machines, Showing All Idle Time in Twenty-four Hours.

chines in operation, he can prevent idleness to a very great extent; but it is possible to loaf on machine work, even with the best and most knowing overseers. A number of ingenious devices have been put on the market to eliminate dependence upon the foreman's knowledge. These automatic-recording devices keep track of the power used per hour, of temperatures, and of pressures at all times. In fact, one can have almost anything recorded. With them one can tell from

the power and time records whether the machine is using up all the power demanded by its maximum capacity, and what is the extent of its idle time during any period.

The following figures and illustrations give an idea of the application of recording instruments to industrial conditions. Fig. 55 shows an application of it to two paper machines. Every time either of the machines stopped, the recording pen for the machine dropped toward the periphery of the card, and the duration of the idleness is shown by the length of the notch. Figs. 56 and 57 show the temperature records, "the chart No. 661, of December 15, 1908, was drawn shortly after the installation of this thermometer on our feed-water system. That of April 13, 1909, is from the same instrument. A comparison of these two will give you an idea of the improvement it is possible to affect in feed-water temperature, with the aid of a sensitive, accurate recorder."[1]

One great advantage of all these recording instruments is that no matter where the operations are carried on, the recording apparatus can be concentrated at any point. In this way it is possible to have all the records in the office of the foreman or superintendents while they are being made. Many plants, however, do not have the instruments so placed, because if they are going to get the greatest efficiency out of their men, it is well to let the workers see just what kind of a record they are making while on duty. The foremen should be around to see the men from time to time, so there is no great advantage gained by having the gauges gathered together in his office, or that of some superior official. The superintendent of a large plant has other duties than watching gauges in operation. His clerk should gather the records and call his notice to any bad reports or unusual showings which need attention. He will thus know what to investigate, and should not be troubled with the records when

[1] *Bulletin*, No. 111, The Bristol Company, September, 1909.

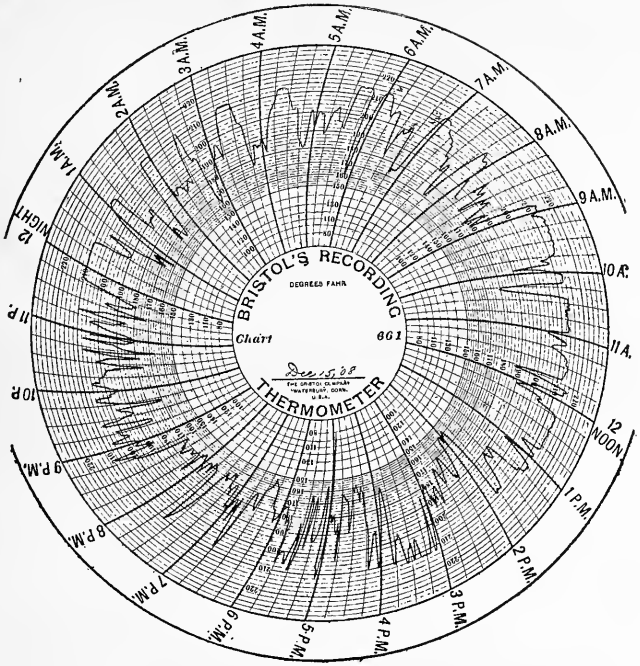


Fig. 56.

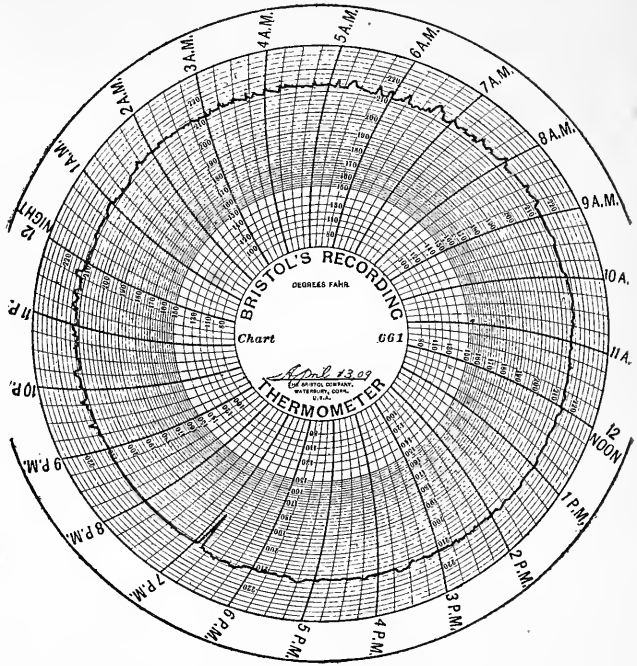


Fig. 57.

Chart of a Bristol Recording Thermometer in a Heating Plant. Fig. 56 is a record a few days after installation; Fig. 57, a record several months later. *By courtesy of The Bristol Company, Waterbury, Conn.*

everything is going as well as present methods make possible. His time under those conditions can be better employed in improving the methods in operation.

If the records kept show that machines are always running at their full capacity, it is fair to expect them to make their promised output. Not only is it necessary to see that machines are making their promised outputs, but care should be taken to see that they make it consistently throughout long lapses of time. Many firms keep daily records of machine outputs in such a way that a person can tell at a glance how the department is running. These records are frequently used in connection with other data. Mr. H. L. Gantt in 1903 published a paper, entitled "A Graphical Daily Balance in Manufacture," to show how a daily balance scheme can be used to facilitate getting work turned out by a department. The advantages of his daily balance scheme, as he presented it, are that it aids the foreman by showing him at a glance what is to be done, and what he has already done on any particular lot. In order to show this he presents some tables indicating his balance sheet scheme, which are here reproduced. (See Fig. 58.)

One will observe that this is merely a plan for keeping track of unfinished material, not unlike some previously described, but the scheme can be used to determine whether the plant is over or under supplied with any kind of machines. Indeed, Mr. Gantt, in his note at the bottom of the right of Fig. 58, calls attention to the fact that it can be so used: "This table shows the way Fig. 58 would look if the works were short of frame-drilling capacity." Any one of the schemes used to keep track of partly finished goods would likewise show any deficiencies in machine equipment, provided the foreman could prove it was not due to lack of labor or to his own insufficiency.

After a firm is satisfied that its machinery is working to its full promised capacity, and has demonstrated that it has

sufficient machinery on hand to do the work required, the next question, and an exceedingly important one, is to determine which machines are really the most economical to

H. L. GANTT
Order No. 77
15 Engines, N. Y. C.

A. L. CO. PRODUCTION SHEET
Schenectady Works, Machine Shop No. 1

PART.	FRAMES.					RAILS.				
Pur. Ord.; Sketch; Pat. or Card Dr. No.										
OPERATION	Rec'd.	Planed	Slotted.	Drilled	Assem'd	Rec'd.	Planed.	Slotted.	Re-Pl. Top.	Re-Pl. Bot.	Drilled.
To Be Begun.											
To Be Finished.											
No. Wanted.	15	15	15	15	15	30	30	30	15	15	30

No. Finished.		Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.
1903.																							
Jan.	20	2	2	2	2	..	..	..	..	..	..	6	6	..	..	..	..	..	..	..	..	..	..
"	21	2	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	22	..	..	2	4	..	..	..	..	..	..	6	12	6	6	..	..	..	..	..	..	..	..
"	23	1	5	..	..	..	..	..	..	..	..	..	..	4	10	..	..	..	..	..	..	..	..
"	24	2	7	1	5	3	3	..	..	..	..	..	..	2	12	4	4	..	..	..	..	..	..
"	26	4	11	2	7	1	4	..	..	..	..	6	18	4	16	..	..	1	1	1	1	..	..
"	27	1	12	..	..	..	..	..	..	..	..	..	..	..	..	4	8	3	4	3	4	..	..
"	28	2	14	2	9	3	7	..	..	..	..	4	22	4	20	2	10	..	..	..	..	..	..
"	29	1	15	1	10	1	8	..	..	..	..	4	26	4	24	4	14	2	6	2	6	4	4
"	30	..	..	1	11	2	10	..	..	..	..	..	..	..	..	..	..	1	7	1	7	4	8
"	31	..	..	3	14	1	11	..	..	..	..	4	30	2	26	4	18	2	9	2	9	..	..
Feb.	2	..	..	..	..	1	12	..	..	..	..	..	..	2	28	4	22	1	10	1	10	..	..
"	3	..	..	1	15	1	13	..	..	..	..	..	..	2	30	6	28	3	13	3	13	2	10
"	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	30	2	15	2	15	4	14
"	5	..	..	..	..	2	15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4	18
"	6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	6	24
"	7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4	28
"	9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	30
"	11	..	..	..	..	..	..	2	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	12	..	..	..	..	..	..	1	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..
"	13	..	..	..	..	..	..	1	4	1	1	..	..	..	..	..	..	..	..	..	..	..	..
"	14	..	..	..	..	..	..	1	5	1	2	..	..	..	..	..	..	..	..	..	..	..	..
"	16	..	..	..	..	..	..	1	6	1	3	..	..	..	..	..	..	..	..	..	..	..	..
"	17	..	..	..	..	..	..	2	8	1	4	..	..	..	..	..	..	..	..	..	..	..	..
"	18	..	..	..	..	..	..	1	9	1	5	..	..	..	..	..	..	..	..	..	..	..	..
"	19	..	..	..	..	..	..	1	10	2	7	..	..	..	..	..	..	..	..	..	..	..	..
"	20	..	..	..	..	..	..	2	12	1	8	..	..	..	..	..	..	..	..	..	..	..	..
"	21	..	..	..	..	..	..	1	13	1	9	..	..	..	..	..	..	..	..	..	..	..	..
"	23	..	..	..	..	..	..	2	15	1	10	..	..	..	..	..	..	..	..	..	..	..	..
"	24	..	..	..	..	..	..	..	..	2	12												
"	25	..	..	..	..	..	..	..	..	1	13												
"	26	..	..	..	..	..	..	..	..	2	15												

This side shows how the table would look if the works were short of frame drilling capacity.

This side shows a record as actually kept.

FIG. 58.—Records Showing Output of Machines. Adapted from a Paper Given by H. L. Gantt, "A Graphical Daily Balance in Manufacture," *Transactions American Society Mechanical Engineers*, vol. xxiv, pp. 1322–36, Figs. 290, 291.

have. A large textile establishment once introduced a number of costly looms which were guaranteed to turn out a certain quantity of cloth within a given period. In testing the looms it was found that they made the output with little

apparent effort, but when it came to examining the output records of the departments, it was found that the looms were not nearly so efficient as they were expected to be. It was found on investigation that the loss in output was due to lost time taken in repairing and looking after the machinery. The manager then kept a record of the amount of repairs and of lost time on the looms, and found to his amazement that they were not nearly so efficient as the ones that had been discarded. Upon further investigation he found that the operators were unfamiliar with the electrical starting devices, and through their ignorance were causing the firm a loss of hundreds of dollars. Many concerns keep records of this type for every machine in their plant, and they find the records are helpful in determining what machines are best suited to their purposes, as well as being useful in determining the repair and depreciation charges. (See Fig. 59.)

Within recent years, some important textile concerns have adopted an effective inventory scheme. A plan is made of every department of the establishment, and on it is indicated every machine or piece of equipment within the section of the plant represented. All pieces in the department are numbered, no matter how small, and are shown in the drawing. (See Fig. 60.) In addition a separate record is kept containing an accurate description of the machines, and also information relating to their prices, dates of purchases, rates of depreciation, from whom purchased, by what power driven, when and how disposed of, and the amount realized on their disposal. (See Fig. 59.)

The drawings alone present considerable information. They show the dimensions of the plant or department, and indicate the exact position of every piece of equipment, while on the same sheet with the drawing is tabulated a brief description of the machines, the number of each, the methods of driving them, and a description of the motive power. A more detailed statement of these items is entered on type-

Card No. 1.

MACHINERY & EQUIPMENT RECORD

Kind of Equipment _____ No. _____

From whom purchased _____ Place _____

Date of purchase _____ Date of receipt _____ Rated output _____

Cost _____ Estimated life _____ Horse Power Consumption _____

Remarks _____

Date		Actual time used	Output	% of Rated output	Lost time	Value of lost time	Reasons for lost time	Repairs	Cost of Repairs	Broken parts	Cost of replacement	Power consumption	% of est. consumption	REMARKS

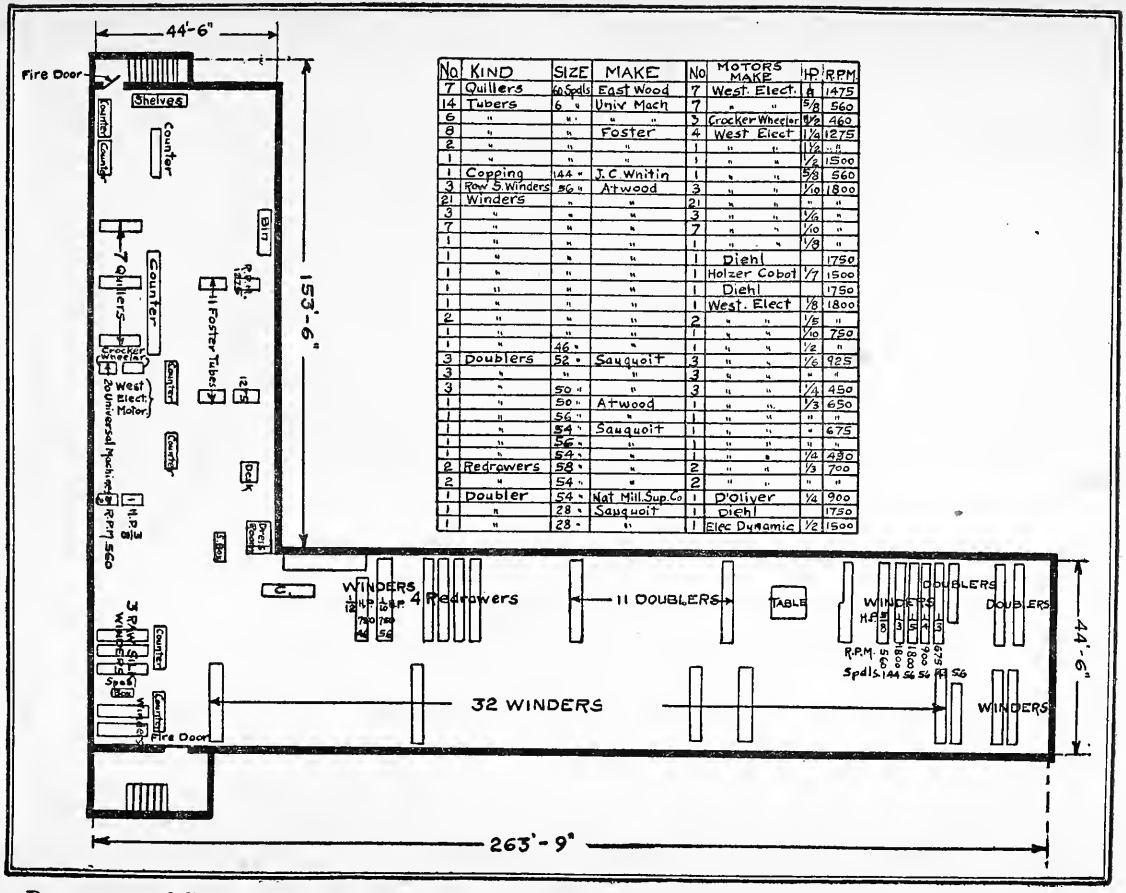
SIZE 6"x8"

FIG. 59.—Machinery and Equipment Record Card.

written sheets, which give full descriptions of the inventory. Whenever a change is made in the equipment, the drawing is altered, the table is corrected to correspond with the change, and the descriptive part of the record is corrected in order to give accurate indication of the new conditions within the plant.

Accuracy and fairness in keeping these inventory records are essential. Insurance companies prefer, at times may even insist, that they be kept by disinterested appraising firms in order to guarantee absolute trustworthiness. It is not, however, an imperative necessity for an outsider to keep such records; because fallacies may be detected from internal evidence. Save in unusual cases, machinery is acquired by purchase, a bill of sale is always given with such transactions, and the machine-manufacturing companies keep their sales records. In case of any dispute the insurance companies can refer to these records; and thus, by making proper depreciation allowances, obtain a close approximation of the value of the machinery from an independent source.

This inventory record possesses a number of advantages. Aside from its importance in case of fire, it keeps the firm thoroughly informed as to the exact status of all its possessions within the plant. The true value of the equipment, both in total and in individual items, is never obscured. Even if the records are not accurately kept they serve as a convenient basis for tracing out the original value. It frequently happens that the assured will, unless he possesses such a record, be unable after a fire to tell just what his losses are. Many times he overlooks important items in his loss statements to the insurance companies, and does not recover amounts to which he is justly entitled. Insurance companies feel quite justified in paring down claims whenever their validity is in any doubt, and there are often possibilities for disagreement where no such record is kept. Seldom, indeed, after large conflagrations, are adjustments



No	KIND	SIZE	MAKE	No	MOTORS MAKE	HP	RPM
7	Quillers	60 Spdls	East Wood	7	West. Elect.	¼	1475
14	Tubers	6 "	Univ Mach	7	" "	5/8	560
6	"	"	" "	5	Crocker Wheeler	1½	460
8	"	"	Foster	4	West Elect	1¼	1275
2	"	"	"	1	" "	1½	"
1	"	"	"	1	" "	¼	1500
1	Copping	144 "	J.C Whitin	1	" "	5/8	560
3	Row 5 Winders	56 "	Atwood	3	" "	1/10	1800
21	Winders	"	"	21	" "	"	"
3	"	"	"	3	" "	1/6	"
7	"	"	"	7	" "	1/10	"
1	"	"	"	1	" "	1/8	"
1	"	"	"	1	Diehl		1750
1	"	"	"	1	Holzer Cobol	1/7	1500
1	"	"	"	1	Diehl		1750
1	"	"	"	1	West. Elect	1/8	1800
2	"	"	"	2	" "	1/5	"
1	"	"	"	1	" "	1/10	750
1	"	46 "	"	1	" "	½	"
3	Doublers	52 "	Sauquoit	3	" "	1/6	925
3	"	"	"	3	" "	"	"
3	"	50 "	"	3	" "	¼	450
1	"	50 "	Atwood	1	" "	1/3	650
1	"	56 "	"	1	" "	"	"
1	"	54 "	Sauquoit	1	" "	"	675
1	"	56 "	"	1	" "	"	"
1	"	54 "	"	1	" "	¼	430
2	Redrowers	58 "	"	2	" "	1/3	700
2	"	54 "	"	2	" "	"	"
1	Doubler	54 "	Nat Mill Sup Co	1	D'oliver	¼	900
1	"	28 "	Sauquoit	1	Diehl		1750
1	"	28 "	"	1	Elec Dynamic	½	1500

By courtesy of Sanquoit Silk Mills Co., Phila., Pa.

FIG. 60.—Plat Record of Machinery and Equipment.

made without friction, and always at the expenditure of considerable sums of money. These sums far exceed the cost of installing a proper fire inventory system, while the after-expenditures are never satisfactory.

If fire never occurs in the plant, the additional work required to keep this type of inventory is so small compared with the advantages gained by having a chart of the equipment constantly in view that it is well worth the trouble to have it, if only to help keep the other records, as shown in Fig. 59, which refers to output and repairs on machines. The plat record shows at a glance all the things that the firm owns, while the other figure gives the details of each individual item. It is an ideal inventory record for machinery.